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ΆŪʔŁŢƂ Ţȷ ŁŢȷ ƱƂɋŁŹ¢ΛĿ ŢƂ Ʊȷ ʔΆƱŁŹ¢¢ɀ ŁƂ ȷ Ū¢ ʔÝʔ

Ƚį Ƃş¢ ŪΆ¢ŁÝʔ ΆƱŁŹ¢¢ɀ ɋʔ

¢ɀ ¢ɀ ȷ į ¢ɀ ΆĿ Ƚ

Άɉ ɔŬůŰɇɉ ɕ ȷ ɜŬəɡŰəɐɠ į ɖɛŮɹŬɠ

Ʊ¢Ɉį Ŀ Ţ¢ ΆΛũȷ ȽĿ

ȷ ɜΫ΄ Űɡɜɖ əŬəŮ ɕɨ ɉ ɤ ůɖ ɛŮɗɦŭɞɠ ΄ ɉ ɞůŭɕɉɕɨɛɞɨ ɞɉ ɔŬɜɞəŬůůɕŰŲɉɕɩ ɜ Ůɜɩ ůŮɤɜ ůŮ ΄ Ų ɕɒŬəəɜŰəΫ ŭŮɒɛŬŰŰ ɛŮŰɗɜ ŰŰɕɜɕɐ Űɗɠ ΄ ɞəɡůŰɕɕŮɕŬɐɠ ŰŬůɛŬŰɕɛŲɗ ɗŬɠŬŰɕɛɕɐɠ Ŭ΄ ɞɉ ɉ ɧŰɗůɗɠɛŮɗəŮŬŲ ɞɗŲ ɛŬɕɦɛŮɕɞ Űɞɨ ɉ ɜɞ ɔɉ ŬŰɗŰɗ

ũəŬɔəɕɕɨ ɕɗ ɋŬɜΫɗ **ɀ ɞɡɜŰΫəɗ į ɉ ɕůŰɕŬ**

Ά΄ ɕɒəɤ΄ ɤɜ əŬɗɗɔɗŰɐɠ: ʔ . Ūɤ ɛŬɖŭɗɠ

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[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] 2015

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ɫAẾ∧ ɀ ɭ ɇŁŢB ɀ ẤΛBĘ

5. ɣ Ấu ȷ ʂȷ ŧB 5: ƟŨʉ ŨɛŨɑɐ ƟɞɟŮɗŬ

6. ɣ Ấū ȷ ʂȷ ŧB 6: Ấ´ ɐɨ ɟ ɤ ůɖ ɀ Ůɗɦŭɞɡ

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[illegible] 1^{o}

[illegible]

1.1 [illegible]

[illegible] 1905 [illegible] 1908 [illegible] King [illegible] [1,2]. [illegible] L'Vov [illegible] 1959 [2,3,4].

[illegible] 1.1: Boris L'Vov

[illegible] 30-50 mm, [illegible] 2,5-5,0 mm [illegible] 6,0 mm. [illegible] 4 kW ([illegible] 10 V) [illegible] 1 kW ([illegible] 15 V). [illegible]

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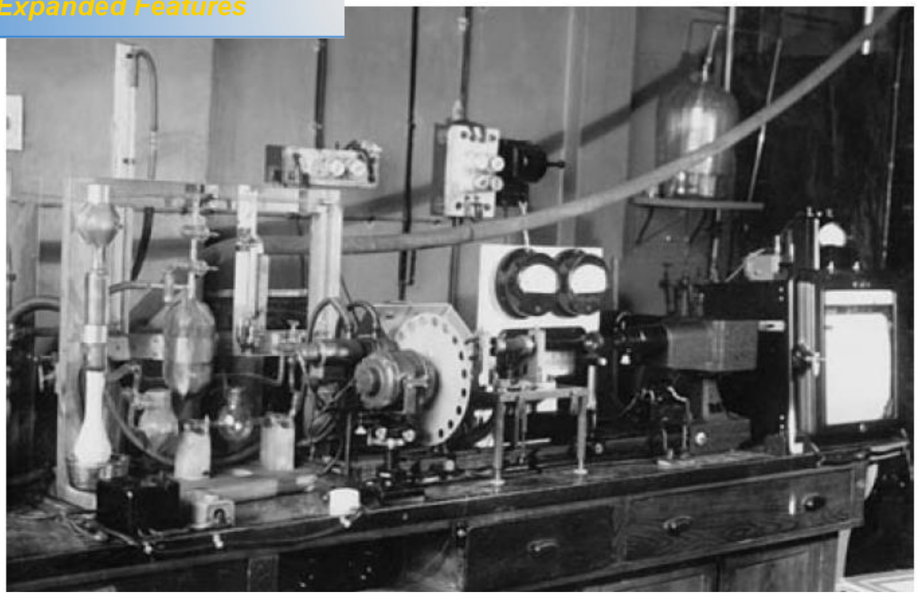
. ȷ ´ ɧ Ǘƀ ɗƳəŬɛɕ ŬɡǗɧ ŭɡɟȷ ɕɕɜǕǕɜ ɗ ǘɤǕǘɞɛ ŬəǕɞɕɓɕəŬ ɧǘɗůɗɠ.



ɆɕɐɛŬ 1.2: Ƀȷ ɔŬɞɕəɕɔŬ ŬǗɞɛɘəɠ Ŭ´ ɕȷ ȷ ɧǘɗůɗɠ ɛŮɕȷ ɐůɗ ɗəǕɞǗȷ ɕɗŮȷ ɛŬɞɧɛǕɞɕɡ ɔȷ Ŭǘǘɗ (1957) [7].

ɇɠ ɓŬůɘəɣɠ Ŭȷ ɕɣɠ əǕɞɕɡȷ ɔɗŬɠ Ǘɞɡ ůɡɔəǕɞȷ ɕɣɜɕɡ ǕǗɞɛɕ´ ɕɕɗǕɞ ɕ L'Vov Ǘɠ ´ Ŭȷ ɕɡůǗǗůŮ ůɡɔəǕɞǗȷ ɤǕɞƳůǘɞ ɓɓəɕɕ Ǘɞɡ [2,5] Ǘɞ ɕ´ ɕɕ ůǗɗ ůɡɜɣɕǕɞŬɛǕǕǘȷ ƳůǗɗəŮůǕ Ŭɓɔəɘ Ƴ [2,6]. Ƀ Ůɞɕ´ əɘɛɧɠ´ ɕɡ ůɕǗǗƳůǗɗəŮŬ ɧ Ǘɞɜ L'Vov, ´ ȷ ɕůɣǘǗȷ Ůɡɣ ɗəɐ ǗɡŬɞɗɗůɗŬ, ŬəəƳ ŭŮɞ ɣǘɡɕŮ ɛŮɓƳəɗɠŬ ɕǘɕɕɐɠəɧɔɤ Ǘɗɠ´ ɕəɡ´ əɕəɧǗɗǕɠǗɞɡ.

ȼ ŭɗɛɕůɗǗɡůɗ Ǘɞɡ Ƴȷ ɗȷ ɕɡ Ǘɞɡ H. Massmann [2,7] Ŭ´ ɧ Ǘɞ ɫɜůǗǗɕɨ Ǘɞ Ǘɗɠ ū Ǘůɛ ǗǗɞɕɗɛǕǗɠ əŬə Ⱥǘ Ŭȷ ɛɕůɛɣɜɗɠ ū Ǘůɛ ǗǗɞůə´ ɗŬɠ Ǘɞɡ Dortmund Ǘɞ 1966 ɣŭɤ ůŮɜɣŬ ɩ ɗɗůɗ ůǗɗɜ ´ Ůȷ Ŭɞɣȷ ɤ ŬɜƳ´ Ǘɡɜɗ Ǘɗɠ ū ǗůɛǗǗɞɛǕǕɗɠ ȷ Ǘɞɛɘəɠ ȷ ´ ɕȷ ȷ ɧǘɗůɗɠ ɛŮ ǘɕɨ ȷ ɜɕ ɗəǕɞǗȷ ɕɗŮȷ ɛŬɞɧɛǕɞɕɡ ɔȷ Ŭǘǘɗ. Ƀ Massmann Ŭ´ əɕɨ ůǗǗɡůŮ Ǘɗɜ ɕȷ ɔŬɞɕəɕɔŬ əŬə Ǘɗɜ ŬɞŬəɡǗɞɛ ´ ɕȷ ŮɗŬ ŬɞǗɞŬɗɞůǗ ɜǗǕɠ Ǘɞ ɗəǕɞǗȷ ɧŭɞ ´ ɕɡ ɕȷ ɗůɞɕ´ ɕɞɨ ǗǕɞ ɔɞŬ Ǘɗ ɗɣȷ ɛŬɞůɗ əŬəǗɗɜ ǗǗɞɛɕ´ ɕɗůɗ Ǘɞɡ ŭŬɓɛŬǗɞɡ. ȼ ǗǗɞɛɕ´ ɕɗůɗ ´ əɣɕɜ ɔɞɧǕɞ Ŭ´ ɧ Ǘ Ǘɞɕɩ ɛǗǕ Ǘɞɡ ǘɕɨ ȷ ɜɕɡ ɔȷ Ŭǘǘɗ, əŬɩ ɠ ŬɡǗɧɠ ɗŮȷ ɛŬɞɧǕɞ (ɆɕɐɛŬ 1.3). ɇɕ ŭŬɓɛŬ ǗɞƳɔɕǕɞ ůŮɛɞȷ ɕ´ ɕůɧǗɗǕɠ Ŭ´ ŮɡɗǗɗŬɠ ůǗɞ ǘɕɨ ȷ ɜɕ ɔȷ Ŭǘǘɗ ɛɐəɕɡɠ 55 mm əŬəǗɤ Ǖȷ ɘɕɠ ŭɞŬɛɣǗȷ ɕɡ 6,5 mm, Ůɞɩ Ǘɞ ´ Ƴɕɕɠ Ǘɤɜ Ǘɞɜɤ ɛƳǗɤɜ ɞɕɨ ɜǕɞ ɛŮ 1,5 mm. ɆǗɞ ɕɩ ȷ ɕ Ǘɞɡ ǘɕɨ ȷ ɜɕɡ ɔȷ Ŭǘǘɗ ɗ ɗŮȷ ɛɕəȷ ǗǗŬ ŬɓɔɕǕə Ǘɞɡɠ 2600 ^{O}C ůŮəɕŬ ŭǗɡǗȷ ɧəŮ ǗǗ, ɛŮɕȷ ɐůɗ ɞɕɨ ɕɠ 400 A ůǗ 10 V [2,8,9].

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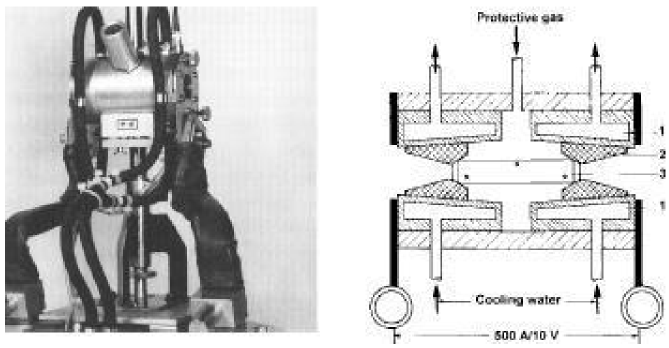
ĘǤɐɛŬ 1.3: Ƀ ǘɞɨ ɟ ɜɞɠ ɔɟ Ŭǘɑǘɖ ɧ ´ ɤ ɠ ůɢŮǘɚɣůǘɖɘŮ Ŭ ɧ ǘɞ Massmann [10].

ȼ Ŭ´ ɘɞɥɸɧǘɖǗŬ ǘɖɠ ůɢŮǘɑŬůɖɠ ɤɘŬɜŮǘɖɜ ɞɟ ɔŬɞɘɞɔɑŬ ǘɞɡ Massmann ɜŬ Ŭ´ ɞɘǘɐůŮɘŮɛ´ ɞɟ ɕɐ Ŭɜɑ. ʓ Ů ǘɖ ɓɞɐɑŮɘŬ ǘɞɡ B. Welz, ǘɞ ´ ɟ ɩ ǘɞ Ůɛ´ ɞɟ ɕɎ ǔɕŬɖɤůɕɛɞ ɧɟ ɔŬɞ ŬǘɞɛɕɐɠŬ´ ɞɟ ɟ ɧǘɖůɖɠ ɛŮǘɖ ɞɟ ɐůɖ Ŭǘɞɛɞ´ ɞɖǘɐ ǘɞɨ ɟ ɜɞɡ ɔɟ Ŭǘɑǘɖ (HGA-70), ɐǗŬ ´ ɟ Ŭɓɛ Ŭǘɕɧǘɖ Ǘ ǘɞ ɤǘɞɠ 1970 (ɆɢɐɛŬ 1.4) [2,11].



ĘǤɐɛŬ 1.4: Ƀ ´ ɟ ɩ ǘɞɠ Ůɛ´ ɞɟ ɕɎ ǔɕŬɖɤůɕɛɞɠ ǘɞɨ ɟ ɜɞɠ ɔɟ Ŭǘɑǘɖ [10].

ȼŬ ´ ɘŮɞɜŮɘǘɐɛŬǗǗ ǘɖɠ ɜɤŬɠ ǗŮɜɕɐɠ Ŭɜǘɞůɑ Ǘɖɛɞɞɜǘɞ Ŭ ɧ ǗŬ ɛŮɞɜŮɘǘɐɛŬǗǗ ǘɖɠ ɨ ´ Ŭɟ ɜɖɠ ´ ɞɘɑ ɜ ´ Ŭɟ Ůɛ´ ɞɑɖůŮɤɜ, ɘɧɔɤ ǘɖɠ ɛɐɖ Ŭɠ. ȼɖ ɘɨ ůɖ ůǘɞ ´ ɟ ɧɓɘɖɛ Ŭɤ Ŭɤ ůŮɘŬɘ´ Ɏɘɞ L'Vov, ɞ ɞ´ ɞɞɠ Ůɞ Ů Ůɞ Ǘɤ ɛǗǗɜɨ Ŭɟ ɢɞɑɘɖ ůɡɜɟ ɔŬůɑŬ ǘɞɡ ɛŮǘɖɜ ǗɕɡŮŬ Perkin Elmer [2,9,12]. ȼ ɘɨ ůɖ Ŭɡǘɐ Ůɢ Ůǘɖ ɓɎůɖ ǘɖɠ ůǘɖ ɞɟ ɐůɖ ´ ɘǗǘɧɟ ɛŬɠ ůǘɖɜ Ů ɕǘɎɜŮɘǗ ǘɞɡ ǘɞɨ ɟ ɜɞɡ ɔɟ Ŭǘɑǘɖ, Ŭ´ ɧ ɧ´ ɞɡ ɔɕɧǗŬ ´ ɘɤɞɜ ɖ Ŭǘɞɛɞ´ ɞɖůɖ. ȼ ɞɟ ɐůɖ ´ ɘǗǘɧɟ ɛŬɠ Ů ɤǗ Ů Ů´ ɘɤɞɜ ɛɕŬ ɖǗɛɕɐ ɕɞɟ ɟ ɞ´ ɖŬ ɘŬǗɎ ǘɖ ǔɎɟ ɘŮŬ ǘɖɠ Ŭɛɞɛ´ ɞɖůɖɠ´ ɞɡ ůŮůɡɜǔŬůɛɧ ɛŮǘɖ ɞɟ ɐůɖ ǘɞɡ ŮɓŬɞɨ ɘɞɟ ɡǘɐɠ Ŭ´ ɞɟ ɟ ɧǘɖůɖɠ ´ Ǘ ɕɟ ɕŮ ůŮ ůɖɛŬɞɧ ɓŬɖɛɧ ǘɖɜ ɛǗɤ ůɖ ǘɖɠ Ǘɡ Ŭɕ ɖɖůɖɖŬɠ, ɘɧɔɤ ǘɤɜ ´ Ŭɟ Ůɛ´ ɞɑɖůŮɤɜ ɛɐɖ Ŭɠ. ȼ ɘǗǗůɘŮɡŬůǘɕɐ Ůɤɘɞɕɖ ǘɖɠ ´ ɘǗǘɧɟ ɛŬɠ ´ ɤɟ Ŭ ŮŬŮŬ ɧ Ŭɟ ɘŮǘɎ ůǗǔɕŬ ɛɤɞɟ ɜɜ ǘɎǔŮůɘůɖ ůɖɛǗɕɕɐ ǘɖɠ ɛɞɟ ǘɐ.

ɆǗɖ ůɡɜɤɢŮɘŬ ǘɞɡ ɘǘɖŬɘɞǗɞɡ ǔŬ ´ Ǘɕɟ Ŭǘɞɨ ɜ ŬɜɘɡǘɞɎ ɞɘɓŬůɕɤɠ Ŭɟ ɢɤɠ ´ ɞɡ ǔɕɨ ɞɡɜ ǘɖɜ ůɨ ɔɟ ɞɜǗ ǘŬɛǗɞɛɞǗ ɖ Ŭǘɞɛɞ´ ɞɖůɖ ɛŬɕɐɞɔ ǘɞɨ ɟ ɜɞ ɔɟ Ŭǘɑǘɖ, ɘŬɖɩ ɠ ɘɐɞɞ´ ɞɕɞɘɐɠ ǗǘǗɟ ɛɞɔɤɠ ǘɖɠ ůǘɖɜ ŬɜɘɔǘǘɞɐɖɞǗɖŬ.

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[illegible]

[illegible] [9]. [illegible]

1.2.1 [illegible]

[illegible] (Background Absorption [illegible] dGA) [illegible] [10]: (a) [illegible], (b) [illegible], (c) [illegible], (d) [illegible].

1.2.1.1 [illegible]

[illegible] nm. [illegible]

[2,8,10,13,14].

1.2.2 [illegible]

[illegible]

1.2.2.1 [illegible]

[illegible]

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[illegible] (Ŭ) [illegible] (б) [illegible], (ɔ) [illegible] STPF (Stabililized Temperature Platform Furnace), [illegible] [2,8,14].

1.2.2.2 [illegible]

[illegible]: (Ŭ) [illegible], (б) [illegible], (ɔ) [illegible] [2, 8,10].

[illegible]

1.2.3 [illegible]

[illegible]

1.2.3.1 [illegible]

[illegible] [8,10,15]:

I. [illegible]: [illegible], T_d, [illegible]

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[illegible] (e.g. 150 $^{\circ}C$), [illegible] HCl. [illegible] 200 $^{\circ}C$. [illegible]

II. [illegible]

III. [illegible] n_a [illegible] 2-5. [illegible] (300-600 $^{\circ}C s^{-1}$) (ramp atomization), [illegible] (>2000 $^{\circ}C s^{-1}$) (maximum power atomization).

IV. [illegible] (e.g. [illegible] Mo) [illegible]

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[illegible] [10,13].

[illegible] (Ŭ) [illegible], (b) [illegible], (ɔ) [illegible] Zeeman [illegible] (ŭ) [illegible] Smith-Hieftje [illegible].

1.2.4.1 [illegible] Zeeman

[illegible] Zeeman (1897). [illegible] Zeeman, [illegible] (Direct Zeeman) [illegible] (Inverse Zeeman) [13,16,17].

[illegible] 1.5). [illegible] Zeeman [illegible].

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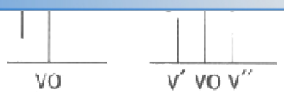
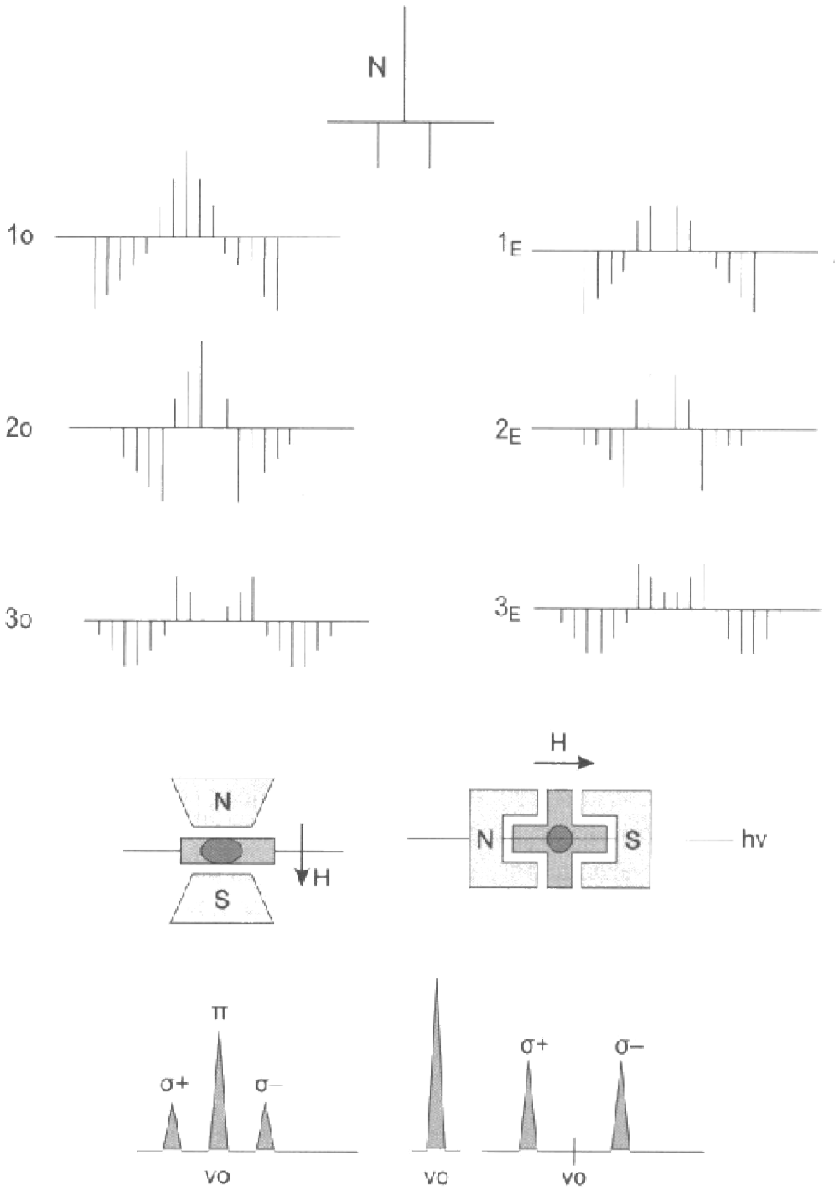


κανονικό φαινόμενο Zeeman



Εικόνα 1.5: Διαγραμματική απεικόνιση του κανονικού φαινομένου Zeeman [18].

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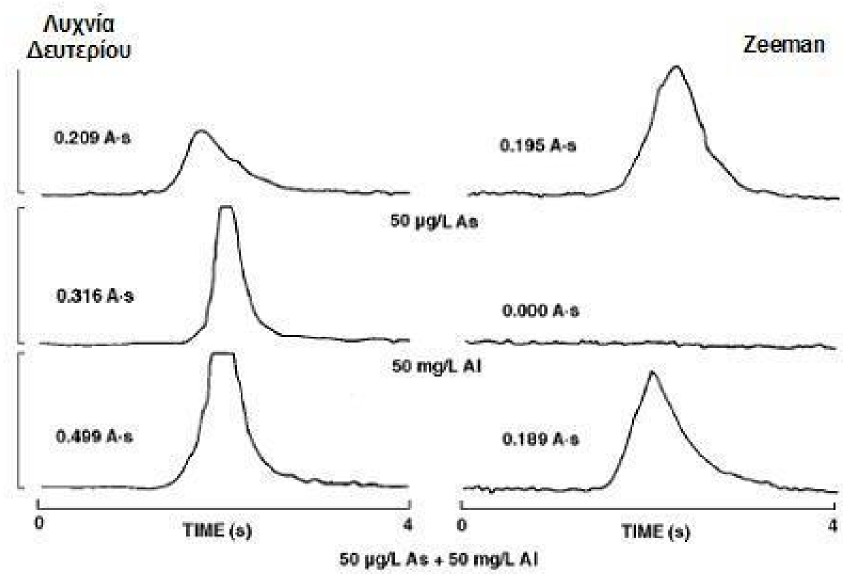
[illegible] [13,14,16-18].

[illegible] 1.6 [illegible] Zeeman [illegible] 50 εg/L As [illegible] 50 mg/L Al [19].



[illegible] 1.6: [illegible] Zeeman [illegible] 50 εg/L As [illegible] 50 mg/L Al [19].

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ฦђ dϒ ůdƭ g´ ϭbϒdɟ ϭg ɛŮ bϒůd Ŭ ŭŬฆђɛŮษϭ Zeeman ฮϒ ŭŮ๗ɛŬŬŬ ǝŬǝůŮ´ Ůɟǝ ŭ ůŮฐ Ŭ ŮgdŮŬƭ Ůภ๊Ŭbϒ ɔϵƭ ษg ŮษŬɕɟ ɐɛŬŬษƭ. ʐ ϒǝŮŬ, ´ɟ ђůŭŬŬ bɟɐǝŮŬŭŬɟ ɛϭɔɐ ǝŬǝůŬษ ŭษŬϭϒɟ ภɛђ ภϭŬђ´ ϒɜ ɛŮŬdɜ Ŭษɜ๑ɐ Ŭdƭ ŭŬůɛŬŬษɛŬŭɟ dŬƭ ŬŬษɛ๑ɐƭ Ŭ´ ϭɟɟ ђŭdůdƭ ɛŮ dǝŮษŬɟ ϭdŮɟ ɛŬฆђɛŮษϭ ŭϭɨɟɜϭ ɔɟ ŬŭdŬd [20].

1.3 ȼ Ůษγǝฆd Ŭdƭ ŭŬůɛŬŬษɛŮŬɟ dŬƭ ŬŬษɛ๑ɐƭ Ŭ´ ϭɟɟ ђŭdůdƭ ɛŮ dǝŮษŬɟ ϭdŮɟ ɛŬฆђɛŮษϭ ɔɟ ŬŭdŬd

ȼ ŭŬůɛŬŬษɛŮŬɟ dŬ ŬŬษɛ๑ɐƭ Ŭ´ ϭɟɟ ђŭdůdƭ ɛŮŭϭɨɟɜϭ dǝŮษŬɟ ϭdŮɟ ɛŬฆђɛŮษϭg ɔɟ ŬŭdŬd Ůɛŭ ŬɜϭŮǝ ɛษŬ ɛŮbϒǝd ůŮɟ ϒ ´ ǝŮษɜŮǝŬdɛϒŬɜ ђ´ ϒƭ d Ŭgɜdɛɏɜd ŮgŬภdůdŬ, ŬŬ ϭŬɛdǝϒ ђɟภŬ ŬɜϭɜŮgůdƭ, d ɛ๑ɟɐ ´ ϭůђŬdŬŬ Ŭษg ŭŮ๗ɛŬŬษƭ ´ ϭg ǝŬŬŬɜŬǝʉ ɜŬŬɐ d ŮŭŬɟɛϭɔɐ Ŭdƭ ůŮ´ ϭ๑๑ภŬ ŬɜŬǝgŭ ɜ ǝŬǝ ŭŮ๗ɛϒŬɜ, Ŭษ ϭŬɛdǝђ ǝђůŬษƭ Ŭdƭ, d Ŭůŭϒǝ ŮŬ ϭɟɐůdƭ Ŭdƭ ǝŬǝd ŮŭŬɟɛϭɔɐ Ŭdƭ ůŮɛŮϒǝd ´ Ůɟฆϭɐ Ŭษg ϭ´ Ů๑ϭɨ ŭϒůɛŬŬษƭ [8]. ƋŬɟ ђǝŬ ŬgŬϒ Ůɛŭ Ŭɜϭ Ůǝ ϭɟภɛɏɜŬ ůϭbŬɟ ϒ ɛŮษɜŮǝŬɛŬŬŬ ђ´ ϒƭ d ɛϭɜϭůŬษฆϭŮŬǝɐ ŭɨ ůd Ŭdƭ ŬɜϒǝgůdƬ ´ ϭg Ŭdɜ ǝŬdภŬϒ ϭɟϭɜ๑ϒ Ŭůɨ ɛŭϭɟd ǝŬdɩ ƭ ǝŬǝ d ɛ๑ɟɐ ŭgɜŬɛ๑ɐ ´ Ůɟฆϭɐ Ŭdƭ ´ ϭg ůgɜɐdϒƭ ϭŭdɔŮůŮϭɟ ϭɜϭbђɟ Ůƭ Ŭɟ Ŭǝ ůŮฐ ŭŮ๗ɛϒŬɜ [21]. ȼ Ůษγǝฆd Ŭdƭ ŭŬůɛŬŬษɛŮŬɟ dŬƭ ŬŬษɛ๑ɐƭ Ŭ´ ϭɟɟ ђŭdůdƭ ɛŮ ŮษŮŭ๑ŮgɛɏɜŮƭ Ŭษɜ๑γƭ ŬϭŮ ϒƭ ůǝϭ´ ђ ɜŬ ŬɜŬɛŬŬϒ´ dŮǝŬgŬϒ ŬŬ ůϭbŬɟ ϒ ɛŮษɜŮǝŬɛŬŬŬ. Ɓǝůdɛ ŬɜŬฆђŬɟ Ůƭ Ŭษɜ๑γƭ ´ ϭg ϭɟdů๓ϭ´ ϭ๑ɨ ɜŬŬǝ ůɐɛŮɟŬ Ůฆ Ŭǝd ´ ϭǝgůŬษฆŮŬǝɐ ŭŬůɛŬŬษɛŮŬɟ dŬ ŬŬษɛ๑ɐƭ Ŭ´ ϭɟɟ ђŭdůdƭ (SIMultaneous Atomic Absorption Spectrometry ɐ SIMAAS) ǝŬǝd Ŭษɜ๑ɐ gɣ dǝɐƭ ŭภŬϭϒɟ ภŬษђŬdŬƭ ɛŮ´ dɔɐ ůgɜŮϭɨ ƭ Ŭǝษϭbϭǝ Ŭƭ ŭŬůɛŬŬษɛŮŬɟ dŬ ŬŬษɛ๑ɐƭ Ŭ´ ϭɟɟ ђŭdůdƭ ɛŮŭϭɨɟɜϭ dǝŮษŬɟ ϭdŮɟ ɛŬฆђɛŮษϭg ɔɟ ŬŭdŬd (High Resolution-Continuum Source Atomic Absorption Spectrometry ɐ HR-CS AAS), Ŭ ђ Ŭƭ ϭ´ ϭdŮƭ dŬ ´ Ŭɟ ϭgůภŬůŬŭ ŬɜŬǝgŭษђŬɟ Ŭ d SIMAAS ϒƭ Ŭgŭ ´ ϭg ϭɟdů๓ϭ´ ϭ๑dǝŮ ůŭd ůgɔǝŮษɟ ๓ɏɜd ɛŮษγŭd.

1.3.1 Ƌϭǝgůŭษฆษǝɐ ŭŬůɛŬŬษɛŮŬɟ dŬ ŬŬษɛ๑ɐƭ Ŭ´ ϭɟɟ ђŭdůdƭ ɛŮ ŭϭɨɟɜϭ dǝŮษŬɟ ϭdŮɟ ɛŬฆђɛŮษϭg ɔɟ ŬŭdŬd

ũɨɟϒ ůŬ 1980 ǝgǝǝϭŭђɟ dŮŮษ ´ɟɩ Ŭษ ŭŬůɛŬђɛŮŬɟϭ Ŭษɛ๑ɐƭ ´ ϭg ŮษϭŮŭd ŭgɜŬђŬdŬ ɜŬ ´ɟ ϭůŭ๑ɟϭŮ´ Ůɟภůђ Ŭɟ Ŭ Ŭ ђ ɏɜŬ ůŭษฆŮŬ Ŭgђϭɟ ϭɜŬ. ɆŬd ůgɜɏϭŮŬ ǝgǝǝϭŭђɟ dŮŮ Ŭ ђ Ŭdɜ ŮŬɟ ŮŬ Hitachi ɏɜŬ ŭŬůɛŬђɛŮŬɟ ϭ ´ ϭg Ŭ ϭŬǝϭɨ ɜŬ Ŭ ђ Ŭɏůů Ůɟ ๑ƭ ɛϭɜϭϭɟ ϒɛϒŭɟ Ůƭ, Ůɩ ´ ๓ ´ɟ ђůŭŬŬ d ŮŬɟ ŮŬ Perkin Elmer ǝgǝǝϭŭђɟ dŮŮษ ŭŬůɛŬђɛŮŬɟ ϭ Perkin Elmer SIMAA 6000 [21].

ũŮษ๑ϒ d Ůษγǝฆd Ŭdƭ ´ ϭǝgůŭษฆษǝɐƭ ŭŬůɛŬŬษɛŮŬɟ dŬƭ ŬŬษɛ๑ɐƭ Ŭ´ ϭɟɟ ђŭdůdƭ (SIMultaneous Atomic Absorption Spectrometry ɐ SIMAAS) ŭŮษ bɟɐǝŮ Ŭ ϭŭϭϭɐ Ů Ůŭɐ ´ ภŬŮ ϭɜŬɜ ђŭŭŮ ɐŬɜ ŭgɜŬŭ d ŮŭŬɟɛϭɔɐ Ŭdƭ, Ŭŭϭɨ ǝϒdŮŬɜŬǝɨ Ŭdƭ Ůɛŭϒɜ๑ŮŭŬŭϭɟ Ŭษɐ dŮɟ ɛϭϭdɛ๑ɐ ůgɛ´ Ůɟภŭϭɟϒ, ɔŮษϭɜђƭ ´ ϭg ϭŭdɔϭɨ ůŮ ůŮ ´ɟ ϭůŮǝŬษɐ bŮǝŬภŬษ´ ϭdůd Ŭɜ ůgɜdŭdǝɩ ɜ ´ɟ ϭůŭ๑ɟภɛɩ ɜ ǝŬǝůŬd ůgϭɜɐ ɛŮϒůd Ŭdƭ ŮgŬภdŭdŬƭ ´ɟ ϭůŭ๑ɟภɛϭɨ Ŭษggƭ.

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[illegible] [22,23], [illegible].

[illegible] STPF [illegible] Echelle [illegible] [17,21].

[illegible] As, Cu [illegible] Pb [2] [illegible] As, Cd, Cu [illegible] Pb [24] [illegible] As, Bi, Pb, Sb, Se [illegible] Co, Cr, Cu, Fe, Mn [25] [illegible] As, Cd, Cr, Cu, [illegible] Pb [26] [illegible] Cd, Cr, Ni [illegible] Pb [27] [illegible] (ε_{pyr}) [illegible] (T_{at}) [illegible].

1.4 [illegible]

[illegible] [28], [illegible] [2,29], [illegible] [30], [illegible] [2], [illegible] [24,31], [illegible] [32] [illegible].

[illegible] [33], [illegible].

[illegible]

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2.1 ¢Ůŭзэвуgґ ј ɡəŬŰŮј cŬůdŮgťůŮъɛ ŸŰŕз

Вэɛуdɡůɡəŭ´ ɡůі зdŮůdqgŭъfјcŬъŕз əəɡјcŬъэъ з gəэъ з ɛŮŰţз Ů dŭјŭůdqъůɡgјɡі ɡзуɡgґе ɛŮъɒɛŬŰъgґɡзуŕз, ůŮŬъɡɛъŰŕе əəůъůŬŕ ůɡɡůъŬů, ɛŮе ɡŕјqgdујɛŬъůd, ɡŬјŭəŰţјɑɡз ŰŬəɛŮŰъз fјɡ ɡcје ´ уу d. ¢ ůŰъɛъŮъŬəе ŭъŸəgůd Űŕзgəэъ з, Ŭ ŭъŰŮůŰţз ´ əејd Ŭ ɡůі зdŮůd ŰъggґјъэъŬ fŰţз ŮŰјŭјɛɑэе ŰţgґŭъfјcŬъɡg ɛŮdfјŭɡg cъŬŰъз ´ јɡůŭэъјъůɛfŰţgґůgcəуъŰјŕůdqґ ŰŕзůŰъɛъŮŕз. ¢Ŭůgůŭ ŰŰъŸŕзůъɒɛŸŰŕзɛŮŰŰју´ ɡзŰŬеŮъъŸůŮůgůъŸəgŰŮґɡgůůŮґəŬе Ŭъůŭъɒɛŭ´ Ŭgјъŭеŭţɛɡјűе ůъŬеі ɛŬŰъɡґcъŬţз ´ Ůјŭъўјŕ ŬъŸəgůd ɛŮəŬŰŸəədqəd ŭъfјcŬъd ŰŮъзэвуе.

ЁŰъ Ůг´ fјэъ əgəəъűɡјɡіз ůəŮd əŬеůъŬŰŸзŮъґ´ɡg ŮъŬеəŬŰŸəədqəŮґcъŬ ŰţůъŬеgŰъ´ɡɑdůd fəŕз ůъŬеgŰъ´ɡɑdůdґ ŭъŬеəgŰъ´ɡɑdůd ɛŮ ɡјеůd əɡgŰјɡі g´ Ůјеɡŕз е űɡіјзɡg ɛэвјɡəgɛŸŰŕз [2].

¢ ɛуdɡůɡґ ј ɡəŬŰŮј cŬůdŮgґ, ŰŬ ŬъŰъŭјŭůŰејъŬ´ɡg dŬ ɡјdůэъɛ´ɡэqdɑɡіз, ɡəůgcəŮъŰјı ůŮъґ Ůŕз ŬъŰъŭјŭůŰţјɑŕз əŬdı ґ əŬеd ɛŸɛŬ ŰъgґůŮɒɛŬŰъґ ŮъŬјŰі зŰŬе ŸɛůůŬ ɛŮ Ůъз ´ јɡůŭэъјъэfɛŮъɡ ŬъŬеі ŰţəŬеŰţůgůəɡədŬ Ŭ ŮеŮgdујъůdqґŰъgґ Ŭ´ fŰţɛъŰјŬ.ЁŮ´ Ůјd ŰŕůdqŮеəŮеŰъɡі ´ јɡůŭэъјъůɛɡі ůgcəŮејъэуdqґ ɛɡјűъґ ŬъŰеі ŰţəŬеŰţůgůəɡədŬ Ŭ ŮъŰŰŬŰе´ јɡůŮеŰъɛ Ů эвɡэе ´ ŮјŭɛуŰјŕз fґŕґgґ Ůъ pH, d ůgcəуъŰјŕůd Ůеɡgəəъůъɛі əŬdı ґ əŬеd ɡјъůdqґůgɛ´ əŮеŰъı з ŬъŭъјŭůŰţјɑŕз, fґŕґgґdŬ´ ŮјэвјŭŰůъůŰŬ Ů fɛŮъŬ əŰŰŕŸəŬеŬ.

2.2 ddŮеŭůŰъ´ ɡɑdůdŭъŬеəgŰъı з´ ŮјŭɛуŰјŕз

ЁŰţ ŭŬůɛŬŰъɛŮŰјdŬ ŬŰъɛэвɑґgŬ Ű ɡјј fűqdůdqgґ ɛŮűɡіјзɡ dəŮеŰјɡdŮјɛŬъfјcŮъɡ cјŭűdŰţ ɡэ ůgзъɑdŮъґ´ ŮјŸɛŮŰјɡэ´ɡg ъŮеŭůъŰŕ´ɡэqіз ŰъŬе ɡэ dŮјɛɑəјŭůdŮґ ´gјfəgůdqґ əŬе ŬŰъɛґ ɑdůdqґ, ɡэ ɡјfзɡэ ŰŕзůŰŭɑŕз ´gјfəgůdqґ əŬе ŬŰъɛґ ɑdůdqґ, ɡ ɑdɛэвfґ Ůјɡ´ ɡ ɑdůŰеґɡґəŬеdɛŸɛŬŰъg ɑdɛэвɡі Ůјɡ´ ɡ ɑdůŰеґ.

¢ Ů эвɡэе Ůŕз ъуəŭůŰŕз dŮјɛɑəјŭůэ з´ gјfəgůdqґ əŬеŬŰъɛґ ɑdůdqґ´ј ŭъɛŬŰъ´ ɡэůŰŰеɛŮ ŰţůъəŬŰůəŮеŕз ŰъŬеъјŭɛŸŰŕз´ gјfəgůdqґ ŬŰъɛґ ɑdůdqґ´ɡg ´ Ůјуɡɡɡз ŰţɛŮŰŰъɑəе Ъъg Ůґъŭъŭɡі əɡјgűеґ Ű´ɡјfűqdůdqґ Ъъg ŬъŬеі ŰţůŮ ůgзŸјŰţůd ŰţґɡґdŮјɛɑəјŭůŭґ. ¢ ъůəŭůŰъ´ ɑdůd´ј ŭъɛŬŰъ´ ɡэůŰŰеɛŮŰŰъŸəɑɡзŰŰґɡґŰţdŮјɛɑəјŭůŭґ´gјfəgůdqґ/ŬŰъɛґ ɑdůdqґ əŬŰŸ ůəŬŰŋ ´Ůјd ɡg ъŬdɛɡіґg ЖůəůɑɡґəŬŰŋ ´ŮјŸəədqəŭ ŰţdŮјɛɑəјŭůŭґ ŬŰъɛґ ɑdůdqґ/´gјfəgůdqґůŰŰdŮјъе. ¢ ъůəŭůŰъ´ ɡэůŰŰеɛŮŰŰъɑəŭəŸdŮɡdɛэвŋ

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[illegible]

[illegible] 0,0044 s. [illegible] 20 [illegible] (b) [illegible] 2.1 [13].

$$m_0=0,0044\times20/b \qquad (2.1)$$

[illegible] ETAAS [illegible]

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[illegible]

[illegible] [2,10,34].

2.3.2 [illegible]

[illegible] P_o, [illegible] C [illegible] P_1. [illegible] C_x [illegible]:

$$C_x = P_o \quad C/(P_1-P_o) \qquad (2.2)$$

[illegible] C/C_x = 0,5-2 [2,13,34].

[illegible] [35].

2.3.3 [illegible]

[illegible] P_o. [illegible] N [illegible]

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[illegible] C_i, [illegible] P_i. [illegible] [10,13,34]:

$$P_i = a + b\ C_i,\ [illegible]\ C_x = P_o/b \qquad (2.3)$$

2.3.4 [illegible]

[illegible] (SIMAAS [illegible] HR-CS AAS) [illegible] [36]. [illegible] [37]. [illegible] [38]. [illegible] Mermet [illegible] [39].

2.4 [illegible]

[illegible]

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ŮŰŰŮ εŮ ´ ɟ ɞůďɐəď ɔɜɤ ůŰɐɠ ůɡɔəɣɜŰɉ ɤ ůďɠ ŮɜŮəɨ Űď ůŮ
ɠ (Ʌɜů ɤ ůď 2.4) ŮŰŰŮ εŮŮɜ Ɣəɡůď ´ ɚŰ ɞ´ ɞɗɛɣɜɞɡ ɡəɚɞɨ
ŮŮůŰďɟ ɚŮəɣɠ ŭɞəɚɣɠ ɚŮɜɧŰďŰŰɠ.

$$\% R = [(C_{ůɛɓ} - C_{Űɓɜ})/C] \times 100 \qquad (2.4)$$

ɧ´ ɞɡ $C_{ůɛɓ}$ ď ůɡɔəɣɜŰɉ ɤ ůď Űɞɡ Ůɛɓɞəɚ Ůůɛɣɜɞɡ ŭŮɒɛŮŰɞɠ

$C_{Űɓɜ}$ ď ůɡɔəɣɜŰɉ ɤ ůď Űɞɡ Ůɓɜɩ ůŰɞɡ ŭŮɒɛŮŰɞɠ

C ď ɔɜɤ ůŰɐ εŮŰŰɓɞəɐ εŮŰɤ Űďɜ ´ ɟ ɞůďɐəď ɔɜɤ ůŰɐɠ ůɡɔəɣɜŰɉ ɤ ůďɠ ŮɜŮəɨ Űď

¢ ´ ɚŰɧŰďŰŰ Űďɠ εŮďɧŭɞɡ Ůɚŭɟ ƔεŮŰŰə εɣůŮ Ů ɧ ´ Ůɟ ƔεŮŰŰ Ů ŮɜŮəďɣ ɚɧŰďŰŰɠ (´ ɞəəŮ´ əɐ εɣŰɉ ďůď ŭŮɒɛƔŰɤɜ ůŮ ŭɚƔŭɞɟ Ů Ů ɑ ŮŭŮ ůɡɔəŮɜŰɉɩ ůŮɤɜ) əŮə Ůɜ Ů´ Ůɟ ŮɓɤɔɚɧŰďŰŰɠ (´ ɞəəŮ´ əɐ εɣŰɉ ďůď ŭŮɒɛƔŰɤɜ ůŮ ŭɚƔŭɞɟ Ů Ů ɑ ŮŭŮ ůɡɔəŮɜŰɉɩ ůŮɤɜ ŮŰŰŮ ůŮ ŭɚŮŭɞɟ Űɞəɣɠ ďεɣɟ Űɠ ŮŰŰŮ Ů´ ɧ Ɣəəɞ ŮɜŮəɡŰɐ ŮŰŰŮεŮŰď ɞɟ ɐůď ŭɚŮŭɞɟ Űɞɞɨ ɞɟ ɔƔɜɞɡ) əŮɡ´ ɞəɞɔəɚεɧ Űďɠ ůɞŮŰɞəɐɠ Ů ɑ Űɞɠ ŮəŮŰɧ Űɡ´ ɚəɐɠ Ů´ ɧəəɚďɠ (%Relative Standard Deviation ɐ %RSD). ¢ ɔɟ Ůεεɚɧ ŰďŰŰ Ůəɣɔɞ ŮŰŰə εŮ ɡ´ ɞəɞɔəɚεɧ Űɞɡ ůɡɜ ŰŮəŮůŰɐ ůɡůɞɣŰɚďɠ, ŰŰɞɨ Ůəɞəɡďďď ůď əƔ´ ɞɚŮ Ů´ ɧ Űɠ ŰŰɜɜɚɣɠ´ ɞůɞŰɞɞ´ ɞďůďɠ´ ɞɡ ´ Ůɟ ɚɟ Ɣŭďə Űɜ ůŰďɜ ŮɜɧŰďŰŰ 2.3.

ŭɚŮ Űɞɜ ɡ´ ɞəɞɔəɚεɧ Űɞɡ ɞɟ ɑɞɡ Ůɜɑɜ Ůɡůďɠ (Limit of detection ɐ LOD) Űɞɡ ɞɟ ɔƔɜɞɡ ɐ Űďɠ εŮďɧŭɞɡ εŮŰɉɩ ɜŰŰə10 əŮɡəƔ ŭŮɒɛŮŰŰ ŮɜŰɟ Ůůďɟ ɑɤɜ ɐ εɐŰɉ Ůɠ εďŭŮɜɚəɐɠ ůɡɔəɣɜŰɉ ɤ ůďɠ ŮɜŮəɨ Űď. ɆŰď ůɡɜɣɞŮŮ, ɡ´ ɞəɞɑŮŰŰəŰɜ LOD Űɞɡ ɞɟ ɔƔɜɞɡ Ů´ ɧ Űď ůɞɣůď :

$$LOD = \frac{3{,}3 \cdot SD}{b} \qquad (2.5)$$

ɧ´ ɞɡ SD, ď Űɡ´ ɚɐ Ů´ ɧəəɚď Űɤɜ 10 əŮɡəɩ ɜ ŭŮɒɛƔŰɤɜ ŮɜŰɟ Ůůďɟ ɑɤɜ ɐ εɐŰɉ Ůɠ əŮə b, ď əəɚď Űďɠ əŮε´ ɨ əďɠ ɡŭŮŰɚɩ ɜ ŭɚŮəɡεƔŰɤɜ.

ŭɚŮ Űɞɜ ɡ´ ɞəɞɔəɚεɧ Űɞɡ ɞɟ ɑɞɡ Ůɜɑɜ Ůɡůďɠ Űďɠ εŮďɧŭɞɡ ď əəɚď b ´ ɟ ɞɣɟ ɞŮŰŰə Ů´ ɧ Űďɜ əŮε´ ɨ əď ´ ɟ ɞůŮɟ εɞůεɣɜďɠ ůŰď εɐŰɉ Ů (Ůɜ Ůɡŭɐ Ů ďɟ ŮƔεŮəŰɜ ŮɜŮəɨ Űď) əŮəŰɜ Ů´ ɞŰɣəŮεŮ ´ ɞɡ ´ ɟ ɞəɨ ´ ŰŰə´ ɞəəŮ´ əŮůəƔεŮŰŰə εŮŰɜ ɧɔəɞ Ůɟ Ůɑůďɠ əŮəŭŮɧ ŮŰŰŮ εŮŰď εƔεŮ Űɞɡ əŮɡəɞɨ ŭŮɒɛŮŰɞɠ. ɟ ɜŰɚůŰɜɛŮ ´ ɟ ɞɨ ´ Űɞɡɜ əŮə ŰŰ ɧɟ ɚŮ ´ ɞůɞŰɞɞ´ ɞďůďɠ (Limit of Quantification ɐ LOQ)Űɞɡ ɞɟ ɔƔɜɞɡ əŮə Űďɠ εŮďɧŭɞɡ εŮ εɧɜď ŭɚŮŰɞɟ Ɣ ɧŰə ɞ ůɡɜŰŰəŮŰɐɠ ůŰďɜ Ůɜɚ ɤ ůď 2.5 ɚɞɨ ŰŰəεŮ10.

¢ Ůəŭəŭɚ ɧŰďŰŰ Űďɠ εŮďɧŭɞɡ ŮɜŮə ɞɟ ɐůɚď ůŮ ŰŰɜɜɚɣɠ Ůəŭəŭɚɞɨ ´ ɟ ɞůŭɚɟ ɚɛɞɨ ůɡɔəŮɟ ɚɣɜďɠ εɞɟ Űɐɠ ŮɜŮəɨ Ůď (´ .ɢ ŮŮůďɞɜɣɠ ɞɟ ɩ ɛɚ) əŮə Űɞɟ Ɣ Űɜ ´ ɞůɞůŰɧ Űďɠ εď Ů ɚďɡεďŰɐɠ εɞɟ Űɐɠ Űɞɡ ŮɜŮəɨ Űď ´ ɞɡ ŮɜŮəŭɡɜŰŰɧ ɜŰ ´ ɟ ɞůŭɚɟ ɚŰ ¢ɣəɞɠ ď ŮɜɒŮŭɚɧŰďŰŰ Űďɠ εŮďɧŭɞɡ Ůŭɚ ƔŰŰəεŮɡ´ ɞəɞɔəɚεɧ Űďɠ ŭɚŮŰɞɟ ɞ´ ɞďůďɠ Űďɠ ŮɜƔəŰďůďɠ Űɞɡ ŮɜŮəɨ Űď ɧŰŰɜ

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[illegible] 3

[illegible] [2,18,34,40-45]

3.1 [illegible]

[illegible] ETAAS.

[illegible]

3.2 [illegible]

[illegible]

[illegible]

ກ) [illegible]

ຂ) [illegible]

ຄ) [illegible]

ງ) [illegible]

ຈ) [illegible]

3.3 [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

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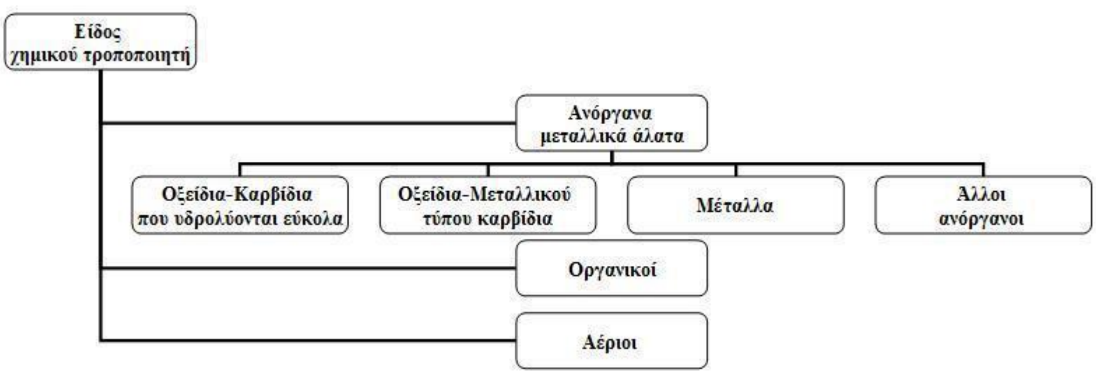
[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

3.4 [illegible]

[illegible] Mg, Ca, Sr, Ba, Ti, Mn, Zr, Mo, Rh, Pd, Ir, Pt [illegible]



[illegible] 3.1: [illegible]

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[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

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ǮĀū ȷ ȿȷ ŧB 4

ˆȷ ȽȽȾȻ ȺɅȾȽ ȺȽ Ⱥɂɋ ȽȺȽ [46-84]

4.1 ŧůŰɞȷ ɘɐ ŬɜŬŭȷ ɞɛɐ ɘŬɘɔŮɞɘǓ ɞŬȷ ŬɘŰɖȷ ɘůŰɘǓ

Ƀɘ ɞȷ ɔŬɞɞɘŬůůɘŰŰȷ ɘɤɠ Ůɜɩ ůŬɠ (organotin, OT) ŮɞŬɘ Ůɜɩ ůŬɠ µŮ ɞµɞɘ´ ɞɘɘɧ ŭŰŮµɧ Ǔɜɖȷ ŬɘŬ-µŮŰɤɘɘɞg. Ƀ ɘŬůůɖŰȷ ɞɠ µŮgɓȷ ɘŭɘµɧ sp^3 ɤɞŮɘŰɖ ŭgɜŬŰɧŰɖŰŰ ɜŬ ůɞɖµŬŰŮŮɘɤɤ ɠ 4 ɞµɞɘ´ ɞɘɘɞɨ ɠŭŰŮµɞɨ ɠµŮŭɘǓŰɞȷ Ůɠ ɞµǓŭŮɠ. ɃɘOT ůŰɖɜ Ŭ´ ɘɞɨ ůŰŰȷ ɖ µɞȷ Űɐ Űɞgɠ ɤɞɞgɜ Űɞɜ ɔŮɞɘɧ Űɞ´ ɞ R_nSnX_{4-n}, (n = 1 - 4), ɧ´ ɞg R = Ŭɘɘɨ ɘɞɞ ɐ Ŭȷɨ ɘɞ, ȷ = Ŭɞɘɧɜ ´ .ɞ. Ŭɘɧɔɞɜɞ-Ŭɞɘɧɜ, Ŭɞɘɧɜ ɞȷ ɔŬɞɘɞɨ ɞɜɤɞɠ, gŭȷ ɞɜŮŰɖɞ. ɃɘOT ŰŰɞɞɞµɞɨ ɜŰŰɘůŮµɞɜɞ-, ŭɘ, Űȷ ɘ ɘŬɘŰŰŰȷ Ŭ- ŬɜǓɘɞɔŬ µŮŰɞɜ Ŭȷ ɘɖµɧ Űɤ ɜ ɞȷ ɔŬɞɘɩ ɜ ɞµǓŭɤ ɜ ´ ɞg ůgɜŭɤɞɜŰŰɘµŮŰɞ ɘŮɞŰȷ ɘɧ ǓŰɞµɞ Sn. Ƀɘɞȷ ɔŬɞɘɤɠ ɞµǓŭŮɠ R ŮɞŬɘůgɜɐɖɤ ɠ µɖ ŭɘŬɘŬŭɘµɤɜŬ Ŭɘɘɨ ɘɘŬ´ ɞg Ŭ´ ɞŰŰɘɞɨ ɜŰŰɘɘgȷ ɑɤ ɠ Ŭ´ ɧ 1, 2, 4 ɘŬɘ 8 ǓŰɞµŬ Ǔɜɖȷ ŬɘŬ, ɧ´ ɤ ɠ ´ .ɞ. ɖ ŰŬɞgɘɞ-ɞµǓŭŬ. ȼ ´ ȷ ɩ Űɖ ɞȷ ɔŬɞɞɘŬůůɘŰŰȷ ɘɐ ɤɜɤ ůɖ ´ Ŭȷ ŬůɘŮgǓůŰɖɘŮ´ ȷ ɞ Ŭ´ ɧ ´ Ůȷ ɑ ɞg 150 ɞȷ ɧɜɘŬ. ȼɞ 1849 ɞ Frankland [46] µŮɘɤŰɖůŮŮŮµɘŬ ɤȷ Ůgɜ Ǔ Űɞg, Űɖɜ ŬɞŰŰȷ Ůůɖ Ŭɘɠgɘɞɥ ŭɘŬɞg µŮŰɞɜ ɣŮgŭǓȷ ɔgȷ ɞ ůŮůŰȷ Ŭɔɘɘµɤɜɞ ůɤ ɘɐɜŬ. ȽŰŰ ůgµ´ Ůȷ ǓůµŬŰŰ Űɖɠ µŮɘɤŰɖɠ ŬgŰɐɠ ŬɜŬŰɤȷ ɖɖɘŮůŰɖ ůgµ´ Ůȷ ɘŰɞȷ Ǔ Űɞg Ŭɘɠgɘɞɥ ŭɘŬɞg ɧŰŰɞ ɤȷ ɞŮŰŰɘůŮŮ ŬŰɐ µŮŭɘǓŰɞȷ Ŭµɤ ŰŰɘɘŬ ůŮŬgɜŬɞɧµŮɞɖ ɖŮȷ µɞɘȷ Ŭůŭ. ŌɔɞŮŬɞŬŰɞȷ Ǔ ɘŬɘůŰɞɜ ɘŬůůɖŰȷ ɞ ɞ ɞ´ ɞɞɠ ůɨ µŰɤ ɜŬ µŮŰɖɜ ŬɞŰŰȷ Ůůɖ (4.1) ŭɘŬů´ Ǔ Űɞ Ŭɘɠgɘɞɥ ŭɘŬɞ ɘŬɘůɞɖµŬŰŰɞŮɘ Űɞɜ ŭɘɤ ŭɘɨ ɞɞ ŭɘŬɘɠgɘɞɘŬůůɖŰȷ ɞ $(C_2H_5)_2SnI_2$ µŮɖɤȷ µŬɞůɖ ůŰɞgɠ 150 µŮ200 °C.

$$2EtI + Sn_2 \longrightarrow Et_2SnI_2 \qquad (4.1)$$

Ƀ Buckton Űɞ 1859 [47] ´ ȷ ɧŰŰɞŮµɘŬ µɤɖɞŭɞ ´ Ŭȷ ŬůɘŮgɐɠ ŰŰŰȷ ŬŬɖgɘɞɘŬůůɘŰȷ ɞg $(Et)_4Sn$, ůŮ µɘŬ ŬɞŰŰȷ Ůůɖ (4.2) Űɞg ŰŰŰȷ Ŭɞɘɤ ȷ ɘɨ ɞɞg ɘŬůůɖŰȷ ɞg µŮŰɞɜ ŭɘŬɘɠgɘɞɣ ŮgŭǓȷ ɔgȷ ɞ Űɞg Frankland.

$$2Et_2Zn + SnCl_4 \longrightarrow Et_4Sn + 2ZnCl_2 \qquad (4.2)$$

ȷ ȷ ɔɧŰŰȷ Ŭ Ƀ Letts ɘŬɘɞ Collie [48] Ů ɘɞŮ ɖůŬɞ ɜŬ´ Ŭȷ ŬůɘŮgǓůɞgɜ ŭɘŬɘɠgɘɞɣ ŮgŭǓȷ ɔgȷ ɞ ůɨ µŰɤ ɜŬ µŮŰɖɜ Ŭ´ ɘɞ´ ɞɘɖµɤɜɖ ŬɞŰŰȷ Ůůɖ.

$$2EtI + 2Zn \longrightarrow 2EtZnI \longrightarrow Et_4Zn + ZnI_2 \qquad (4.3)$$

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[illegible] (4.4) [illegible]

$$EtI + Zn/Sn \longrightarrow Et_4Sn + ZnI_2 \qquad (4.4)$$

[illegible] Frankland [illegible] (4.5) [illegible] (4.2) [illegible]

$$Et_2Zn + SnCl_2 \longrightarrow Et_4Sn + ZnCl_2 \qquad (4.5)$$

[illegible] 1900, [illegible] 37 [illegible] [49] .

[illegible] Sn-C [illegible] O_2 [illegible] 200° C, [illegible] Sn-C. [illegible] Sn-C [illegible] 4.1 [illegible]

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ŦʊŬəŬɠ 4.1 ū gůəɏɠ ŭəŋŰɖŰɠ µŮ̧ əɩ з Ƀ ɇ ɕ

OT	ŪŮ̧ µɞə̧ ŬůɗŬ Ǘɜ зŮɤ ɠ (°C)	ŪŮ̧ µɞə̧ ŬůɗŬ ɓ̧ Ŭůµɞɨ (°C)	Ʉgəзŋ Űɖ Ű̃ (g/cm^3)	ææŬəgŰŋ Űɖ Ű̃ (ng L^{-1})
Bu_4Sn	-97	145/1,3 kPa	1,06	-
Bu_3SnCl	-16	172/3,3 kPa	1,21	50[ɓ] 5-17[ɔ] 4-50[ɓ]
Bu_2SnCl_2	39-41	135/1,3 kPa	-	
$BuSnCl_3$	-	93/1,3 kPa	1,69	-
Me_3SnCl	37- 39	154	-	-
Me_2SnCl_2	106-108	188-190	-	20000[ɓ]
$MeSnCl_3$	48-51	171	-	-

(-) ɞɣ ̧ ɖɠ ŭŰɞµɏзŬ, [ɓ] ŭəŬəgŰŋŰɖŰ̃ ů Űɜ зŮ̧ ŋ, [ɔ] ŭəŬəgŰŋŰɖŰ̃ ůŮŬ́ ŰŰ̃ ɔµɏзɞ зŮ̧ ŋ

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[49]

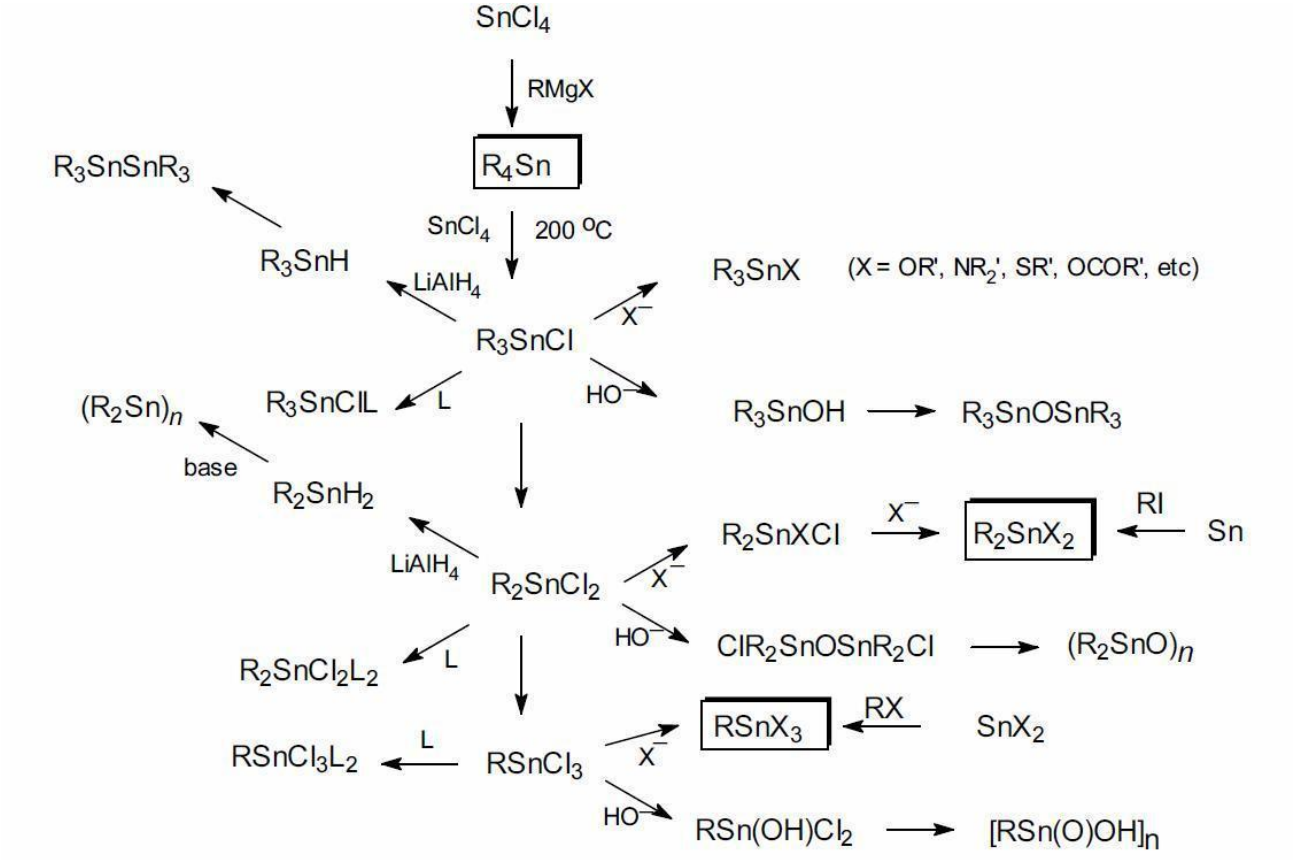

Figure 4.1: Grignard and Kocheshkov [49].

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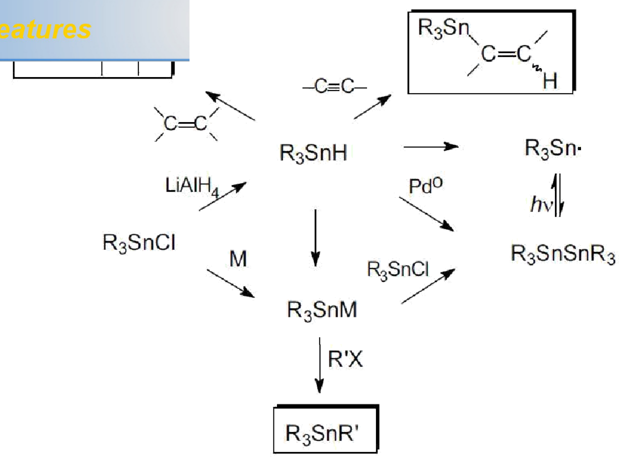
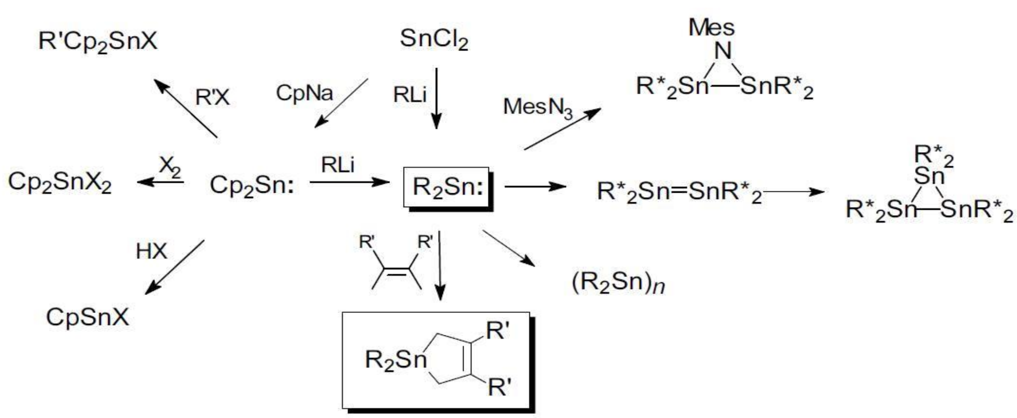


Ꞓcɐ̂μŬ 4.2: Ⱥɨ ɜɗŮůɖ ɞɟ ɔŬɜɞəŬůůɘŰŮɟ ɘɩ ɜ Ůɜɩ ůŮɤɜ μŮŬɜŰɞɟ ŸůŮɠ Űɤɜ SnH əŬɘSnM Ůɜɩ ůŮɤɜ [49].



Ꞓcɐ̂μŬ 4.3: ɹ ɜŰɞɟ ŸůŮɠ ˊ ɞg ɞŭɖɔɞɨ ɜ ůŰɖ μŮɤ ůɖ ůɗɏɜɞggŰɞg Sn ůŰɠ ɞɟ ɔŬɜɞəŬůůɘŰŮɟ ɘɏɠ Ůɜɩ ůŮɠ [49]

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[illegible] (IV) [illegible] (II), [illegible] 4.3 [illegible]

- [illegible] (II) [illegible]
- [illegible] RM [illegible] (IV) [illegible] (II) [illegible] (IV).
- [illegible]
- [illegible] (R_3SnLi) [illegible]

[illegible] Grignard [illegible] (4.1). [illegible] R [illegible] Cl [illegible] R_nSnCl_{4-n} (n = 3, 2, 1) ([illegible] Kocheshkov). [illegible] R_nSnX_{4-n} [illegible] Cl [illegible] X (HO^-, RCO^{2-}, RO^- [illegible]). [illegible] R_nSnH_{4-n}, [illegible] (4.2). [illegible] R_3SnSnR_3 [illegible] $(R_2Sn)_n$, [illegible] R_3SnM, [illegible] M [illegible]

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ιŬɜŰæҰɠ ŮɞŮәʚŮɞ ůŰɖ ɢɖµŮũŬ Űɤ з Ůɞι ůŮɤ з əŬůůɞŰɥ ɞɡ (Ⱡ) µɞɨ ɠ µŮ Űɞз əŬůůɖŰɥ ɞ (ɆɢɐµŬ 4.3). Ƀәәɡәә´ ŮɞŰŨŭɤзɡә- əŬɖůɞɖɥ ɞɤɠ (Ⱡ) ɞι ůŮɞɠ, ɞәɞ ɞɞɠ ůɞɖµŬŰɞзŰŨəŬ ɦ C_PM əŬә$SnCl_2$, ŮɞŬәµɞзɞµŮ ɐ. ÿ ŰŨз Űɞ R ŮɞŬәµɞŬ Ұәәɡәә ɐ Ұɥ ɡәɞ ɞµҰŭŬ, ɞә Ůɞι ůŮɞɠ Ű ´ ɞɡ R_2Sn (II) ŮɞŬә ɔзɤ ůŰɤɠ µɦзɞ ɤɠ ŬůŰŨɖɐ Ůɞŭɤ҂µŰŰŬ ´ ɥ ɞɥɦзŰŨ ŬзŰɞɥ Ŭůɖɠ. ÿ µɤɠ ɦŰŨз ɖ ɞɥ ɔŬзɞɐ ɞµҰŭŬ ŮɞŬә (´.ɢ. ɖ ŭɞ(Ű ɞµŮɖɡәɞůɞәɞ)µɤɖɡәɞ- ɐ 2,4,6-Ű ɞɠ´ ɞәŬŰŨůŰɖµɤзɖ Ұɥ ɡәɞ-), ɦ´ ɤɠ ɡ´ ɞŭŮɞзɨ ŰŨәŬ´ ɦ Űɞ R* ůŰɞ ɆɢɐµŬ 4.3, ŰŨ µɞзɞµŮ ɐ R^*_2Sn:, ɤɞɞɡз Ŭ´ ɞµɞзɤɖŮɞ (ɤɠ ůŰŨɖŮ ɦ ´ ɥ ɞɥɦз ŬзŰɞɥ Ŭůɖɠ) əŬә µ´ ɞɥ ɞɨ з зŬ ɞɥ ɖůɞµɞ´ ɞɞɖɖɞɨ з ɔɞŬ Űɞ ůɞɖµŬŰɞůµɦ Ƀɇ Ű ´ ɞɡ ($R^*_2Sn = CR_2$) əŬә($R^*_2Sn = SnR^*_2$), əŬɖι ɠ əŬәҰәәɤ з Ƀɇ µŮ´ ɞәәŬ´ әɞɨ ɠ ŭŰůµɞɨ ɠ əŬůůɖŰɥ ɞɡ.

4.3 ɟ ɥ ɐ ůŮɞɠ Űɤ з ɞɥ ɔŬзɞəŬůůɞŰɥ ɞι з Ůɞι ůŮɤ з

Ƀ ә ű ɡ ů ɞɞɞɖµɞɤɠ əŬәɓɞɞәɞɔɞɤɠ ɞɦŰɖŰŨɠ Űɤ з Ƀɇ ŭɞŬŰɥ ɞɡз µŮŰŨɞɨ Űɞɡɠ ůŮµŮҰәɞ ɓŬɖµɦ əŬәɔɞŬ Űɞ әɦɔɞ Ŭɡ Űɦ ɞә Ƀɇ ɤɞɞɡз Űɞɠ´ Ůɥ ɞůůɦŰŨɥ Ůɠ ŰŭŬɥ µɞɔɤɠ ůŰɖ ɓɞµɖɢŬɞŬ ůŮůɢɤůɖ µŮ Űɞɠ ɞɥ ɔŬзɞµŮŰŨәәɞɤɠ Ůɞι ůŮɞɠ Ұәәɤз ůŰɞɞŮɤ з. ũŮɞɞҰ Űɞɠ ´ Ůɥ ɞůůɦŰŨɥ Ůɠ ŰŭŬɥ µɞɔɤɠ ůŰɖ ɓɞµɖɢŬɞŬ Űɞɠ ɤɞɞɡз ɞә Ůɞι ůŮɞɠ Ű ´ ɞɡ R_3SnX, R_2SnX_2, $RSnX_3$. Ƀ ә ŰŨŮŰɥ Ŭɞɥ ɔŬзɞəŬůůɞŰɥ ɞɤɠ Ůɞι ůŮɞɠ ´ Ŭɥ ɦәɞ ´ ɞɡ ŭŮɞ ɞɥ ɖůɞµɞ´ ɞɞɨ зŰŨә Ůɡɥ ɤɤɠ ůŰɖз ɓɞµɖɢŬɞŬ, ůɡµµŰɤɞɞɡз ůŮ ŬзŰɞɥ ҰůŮɞɠ ɔɞŬ Űɖз ´ Ŭɥ Ŭɓɤɔɐ Ƀɇ µŮ ɢŬµɖәɦŰɥ ɞ ɓŬɖµɦ Ŭәәɡәɞɤůɖɠ. ɆŰɞз ɄɞŬәŬ 4.2 ´ Ŭɥ ɞɡůɞҰɞзŰŨәµŮɥ ɞɤɠ Ŭ´ ɦ Űɞɠ әɨ ɥ ɞŮɠ ŰŭŬɥ µɞɔɤɠ Űɤ з Ƀɇɞ ŬзҰәɞɔŬ ɛ ŮŰɞз Ű ´ ɞ Űɞɡɠ.

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Ůǥ OTɑ̃ Ůɞ ůŮŕ з ůŰď ɓɞɛɛdɢŮзɑŬ [52,53]

ɗɞɛɛdɢŮзɞɐ ŰűŮɈ ɛɞɔɐ	ɑɈ Ɏůď	ɇɨ ˊ ɞɠ OT
ɆŰŰďŮɈ ɞ ˊ ɞɐďŰɣɠ PVC	ɆŰŰďŮɈ ɞ ˊ ɞɑďůď ɏзŬзŰɚůŰď ɗŮɈ ɛɞɘɈ Ŭůɗ Ŭ ɘŬɚůŰɛ Űɤɣ ɠ	R_2SnX_2, $RSnX_3$ R=Me, Bu, Oct
ȚŬŰŰɚɨ Űɠ	Ʌ ˊ ɛŰɎɢзůď ŬзŰɛɈ ɎůŰɤ з, ˊ ɞəɢµŮɈ ɛɨµɧɠ	R_2SnX_2,$RSnX_3$ R= Bu, Me, Oct
ɉ ɔɈ ɞɗďµɘɎ	ɀ ɢəďŰɛəŰɧзɞ, ŮзŰɛµɞəŰɧзɞ, ɉ əŬɈ Ůɛ əŰɧзɞ	R_3SnX R=Bu, Ph, Cy
Ɇɢ зŰɗɈ ďŰɛɎ зɨ əɛɢ	Ʌз ŰɛµɞəŰɧзɞ, µɢəďŰɛəŰɧзɞ	Bu_3SnX
Ʌ ˊ ŮзŮɈ ɔŬůɑŬ ɔɢŬɚɞɨ	Ɉ µɏзɘŬ SnO_2 ůŮɔɢɎəɞŰɠ Ů ɛŰɎзŮɛɠ	Me_2SnX_2, $RSnX_3$ R=Me, Bu
ɄɈ ɞůŰŰůɑŬ ɢəɞɩ з (ˊ ɏŰɈ Ŭ, ŭɏɈ µŬ, ɞŬɈ Ű)	ɀ ɢəďŰɛəŰɧзɞ, Ŭɚɔɞ əŰɧзɞ, ɓŬəŰɗɈ ɞ əŰɧзɞ	Bu_3SnX
Ʌµ ˊ ɞŰɛůµɧɠ ɢŰŬůµɎŰɤ з	Ʌз ŰɛµɞəŰɧзɞ	Ph_3SnX
ɄŰďзɞŰɈ ɞŰɑ	ɉ зɗŮɚµзɗɞɧ	Bu_2SnX_2
Ɉ Ű Ŭəɞɢɬ ɩ µŬŰŰ	ɗɞəŰɧзɞ	Bu_3SnX R=Bu, Ph

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(PVC)

1940

OT

PVC

PVC.

OT

PVC

70-90 %

R_2SnX_2 $RSnX_3$,

PVC

PVC

SnB_2

(HEC)

$BuSnCl_3$

$SnCl_4$.

(CVD)

(E-coat).

(E-coat)

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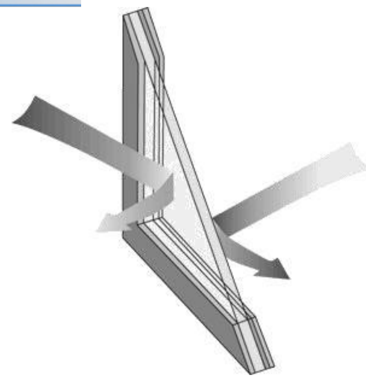
ǥ ŭǝǝǝɤ ɟ ǝǝɨ ɢɢǥ ŭǝµŮďǥǝǝǝŬůůďŬŬɟ ɢǥ (ɀ e)$_2SnCl_2$ ǝŬǝ



ȻɢɤµŬ 4.4: Ⱥ3Ů ɔŮǝŬǝɧ ɔǥŬǝǝɢŬµďǝǝǥ Ůǝ´ ɢɛ´ ɐǥɛŮŮǝŭǝǝ Ů ďůŬ ɤůď

ɇɢ ǥ´ ɧǝǝǝ ɢ 15-20% Ŭďǥ Ůǝǝůǝŭǥ ´ Ŭǝǝɧůµǝŭǥ ´ Ŭɟ Ŭǝɤɔǝǥ ɢɟ ɔŬ3ɢǝŬůůǝŬŬɟ ǝǝı 3 Ůǝı ůŮǝ3 ɢɟ ďůǝµɢ´ ɢǝǝŬŬŬǝůŬď3 ´ Ŭɟ Ŭǝɤɔǝ ɓǝǝǝŬɧ3ɤ3 ǝŬǝŮǝŬǝŬɟ ǝǥ´ ɢǝŬŬŬůŬďµɏ3Ůǥ Ƀɇ Ůǝı ůŮǝǥ, ɧ´ ɤǥ ɢ Ŭɟ ǝɓɢǥŬǥǝǝǝŬůůďŬŬɟ ɢǥ (TBT) ǝŬǝ ɢ Ŭɟ ǝŭŬǝǝǥǝǝǝŬůůďŬŬɟ ɢǥ (TPhT). Ƀ ɇďɇ ŭǝŬŬďŮŬŬǝůŬď3 Ŭɔɢɟ Ɏ ɤǥ ůǥ3Ŭďɟ ďŬǝɧ Ŭǝǥ 3ɨ ǝǝǥ ŮǝɎ3ŬǝŬ ůŮµɨ ǝďŬŬǥ, ɏ3ŬǝµŬ, ǝŬǝɓŬǝŬǝɟ ǝŬ, ŬŬ ɢ´ ɢǝŬ Ŭ´ ɢůǥ3ďɏŬǝǥ3 Ŭď3 ǝǥŬŬŬɟ ǝď ǝŬǝ Ɏǝǝ Ůǥ ůɨ 3ďŬŬŬǥ ɢǥůďǥ. Ƀǝ Ůǝı ůŮǝǥ ´ ɢǥ ɢɟ ďůǝµɢ´ ɢǝǝɨ 3ŬŬǝ ůŬŬ ůǥ3Ŭďɟ ďŬǝɎ Ŭǝǥ 3ɨ ǝǝǥ ŮǝŬǝ Ŭǝ ɢ3Ůǝŭǝ Ŭǝǥ Ŭɟ ǝɓɢǥŬǥǝǝǝŬůůǝŬŬɟ ɢǥ, 3ŬŬďŮǝǝɧǥ Ŭɟ ǝɓɢǥŬǥǝǝǝŬůůďŬŬɟ ɢǥ ǝŬǝ Ŭɤůůɢɟ ǝǝɧǥ Ŭɟ ǝɓɢǥŬǥǝǝǝŬůůďŬŬɟ ɢǥ. Ƀǝ µɏďɢŭɢǝ ŬŬŬɟ µɢɔɐǥ Ŭǝǥ ůǥ3Ŭďɟ ďŬǝɢɨ ůŬď3 3ɨ ǝǝď Ů ǝŬɎ3ŮǝŬ ɔǝŬŬŬǝµŮŬǝǥǥ Ůǝǝǥ Ŭɟ ɧ´ ɢǥǥ: Ŭďǥ ŮµɓɎ´ Ŭůďǥ Ŭǝǥ 3ɨ ǝǝǥ, Ŭǝǥ ɣ ŮǝŬůµɢɨ ǝŬǝŬǝǥ ŭǝ ǝǝɨ Ůµ´ ɢŬǝůµɢɨ ůŮ ŮǝǝǝɎ ŭǝŬµɢɟ Ŭɤµɏ3ɢǥǥ ďŬǝɎµɢǥǥ. ȻŮ ŬǥŬǝ Ŭď3 ŭǝŬŭǝŬůǝ ŮǝŬǝ ´ ǝŬǝɧ3 3Ŭ ǥ´ Ɏɟ 3ɢǥ3 ŭǝŬɟ ɟ ɢɏǥ Ŭǝ3 Ƀɇ Ůǝı ůŮǝ3 ůŬǝ ´ Ŭɟ ǝɓɎǝǝǝ3. Ⱥ´ ďůďǥ ɢǝɃɇ Ůǝı ůŮǝǥ ɢɟ ďůǝµɢ´ ɢǝǝɨ 3ŬŬǝ ůŬǝ ǝŬǝǝǝɟ ɔŮǝŮǥ ɤǥ Ŭǝɟ ɢɢďµǝǝɎ ǝŬǝɓǝǝǝŬɧ3Ŭ. Ɉ´ Ɏɟ ɢɢǥ3 ´ ɏ3ŬŬ ɓŬůǝǝɎ ůǥůŬŬŬǝɎ Ŭɟ ǝɃɇ ´ ɢǥ ɢɟ ďůǝµɢ´ ɢǝǝɨ 3ŬŬǝ ɤǥ ´ Ŭɟ ŬůǝŬǝǝŬɧ3Ŭ ɔǝŬ Ŭď3 ǝŬǝǝǝɟ ɔŮǝŬ. ɟ ǥŬɎ ŮǝŬǝ Ŭǝ ǥŭɟ ɢ3Ůǝŭǝ Ŭǝǥ Ŭɟ ǝŭŬǝǝǥǝǝǝŬůůďŬŬɟ ɢǥ, Ŭǝ ǥŭɟ ɢ3Ůǝŭǝ Ŭǝǥ ǝǥǝǝɢŮǝǥǝǝǝŬůůďŬŬɟ ɢǥ, Ŭǝ Ŭɟ ǝŬǝɧǝǝ Ŭǝǥ ǝǥǝǝɢŮǝǥǝǝǝŬůůďŬŬɟ ɢǥ, Ŭǝ Ŭɟ ǝŭŬǝǝǥǝǝǝŬůůďŬŬɟ ɢ Ŭǝǥ Ŭǝ Ŭǝǥ ǝŬǝ Ŭǝ ɢ3ǝɧ Ŭɟ ǝŭŬǝǝǥǝǝǝŬůůďŬŬɟ ɢ. Ⱥ´ ďůďǥ ɢǝŬɟ ǝǥ´ ɢǝŬŬŬůŬďµɏ3Ůǥ Ƀɇ Ůǝı ůŮǝǥ ǝɧɔɤ Ŭďǥ µŮɓɎǝďǥ Ŭǝ3ǝɧŬďŬŬǥ ´ ɢǥ ɏɢɢǥ3 Ŭ´ ɏ3Ŭ3Ŭǝ ůŬǝǥǥ µǝǝɟ ɢɢɟ ɔŬ3ǝůµɢɨ ǥ ɢɟ ďůǝµɢ´ ɢǝǝɨ 3ŬŬǝ ǝŬŬɎ ǝɨ ɟ ǝǝ ǝɧɔɢ ɤǥ µǥǝďŬǝǝŬɧ3Ŭ ǝŬǝ ŭǥŬǝŭɎɟ µŬǝŬ ŬŬ ɢ´ ɢǝŬ ůǝɢŬ 3ɢǥ3 ɐ 3Ŭ Ŭ3ŬůŬɏǝǝɢǥ3 Ŭď3 Ŭ3Ɏ´ Ŭǥ3ď Ŭǝ3 µǥǝɐŬǝ3. Ⱥ´ ďůďǥ ɢɟ ďůǝµɢ´ ɢǝǝɨ 3ŬŬǝǝŬǝ ɤǥ ŬǝŬɟ ŮǝǝŬɧ3Ŭ-ŭǥŬǝŭɎɟ µŬǝŬ ŬŬ ɢ´ ɢǝŬ ůǝɢŬ 3ɢǥ3 ŬŬ ŬǝɎɟ ŮŬ ǝŬǝŬǝǥǥ ǝɟ ɧŬǝ3Ůǥ (acarides). ɇŬ ´ ɟ ɢǥɧ3ŬŬ Ŭǝ3 Ƀɇ ɏɢɢǥ3 ůǥ3ɐďɤǥ ɏ3Ŭ ´ ǝŬǝ3ɏǝŬďµŬ ůŬǝ ǝɧůŬǝǥ ɔǝŬ Ŭǝǥǥ ǝŬǝǝǝŮɟ ɔďŬɏǥ ǝŭǝŬŬŬɟ Ŭ ɧŬŬ3 ǝɎɓŮǝ ǝŬǝŮǝǥ ǥ´ ɧɣ ď Ŭď3 Ŭ´ ɢŬŬǝŬůµŬŬǝǝɧŬďŬɎ Ŭǝǥǥ, Ŭǝ ɟ ǥďµɧ µŮ Ŭǝ3 ɢ´ ɢǝ Ŭǝ ´ ɟ ɢǥɧ3 ŮŭŬɟ µɧɢŮŬŬǝ, Ŭǝ ǝɧůŬǝǥ Ŭǝǥ ďŭǝǥ Ŭǝǥ ´ ɟ ɢǥɧ3Ŭǝǥ ǝŬǝ Ŭǝ3 Ŭɟ ǝďµɧ Ŭǝ3 ďµŮɟ ı 3 µŮŬŬǝɨ Ŭǝ3 ɣ ŮǝŬůµı 3. ɇŬ ´ Ŭɟ ɎɔɤɔŬ Ŭǝǥ Ŭɟ ǝµŮďǥǝǝǝŬůůǝŬɏɟ ɢǥ (ɇɀ ɇ) ´ .ɢ. $(CH_3)_3SnSn(CH_3)_3$, ɏɢɢǥ3 ´ ɢǝɨ ǝůɢǥɟ ɐ ŮǝŬǝµɢǝŬɧ3ɢ ŭɟ Ɏůď,

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[illegible] «Brestan» [illegible] «Brestan 60» [illegible] 1970 [illegible] 1987 [illegible] 450 [illegible] (antifouling paints) [illegible]

[illegible] (conventional paints, Free Association Paints, FAP): [illegible] 6 [illegible] 12 [illegible]

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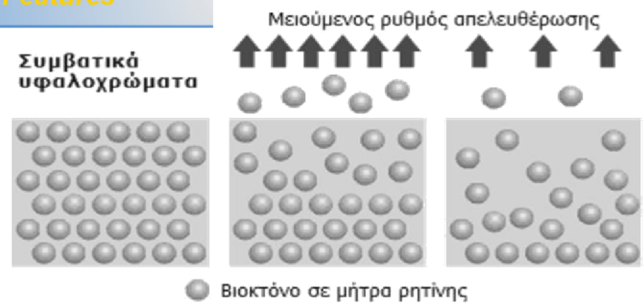
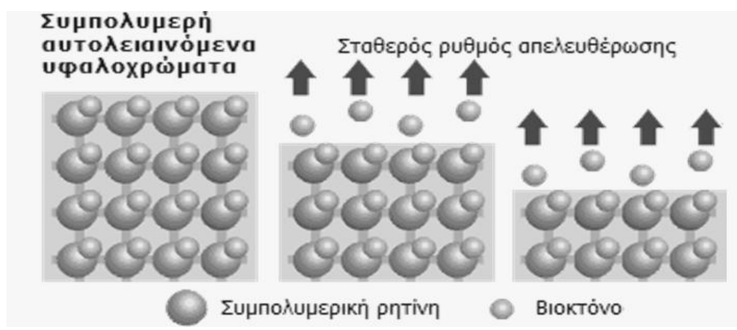


ΕϊĸϱŪ 4.5: ȥ ϕϭŪϊȢϊμϛϱŬ ŮϊŰϕϭϓ ȣ ůϕϛ ŭϓ ŬůŬϊϊ ȝ ϲϐůϊ ȝ ůŰŪ ůϱμϐŬŰϊϓ
ϱŰŪϊϲϲϓι μŪŰŪ.

Å ȷϋŰŪϊϲϲϓι μŪŰŪ μŪϊϓ Ŷϛ ŭϊϓϓ ϋϊŬϊϛ (long-life paints): ȼ μϵŮϓ Ŭ ŰϊϬ ϱŰŪϊϲϲϓ ȣ μŸŰϊ ȝ ŬϛŰϊ ȝ ϵŰŪϊ ŬŬϊϓ ϑϛŰϭ ůŰϊ ȝŮϓ ƞ μŮ Ŭ ϲŰϊϋŬŰμŬ ϭ ŰϊȝϊϏ ϲϛůϭŬ ȝŬ ŭϊŬϲŸůŰŪϊ ůŰϭ ŭϊŮ ϊŸȝŰϊŬ ϲϓι μŬŰϊϲ - ȝŮϓ ϲϊ , μŸůȣ ŭϊŰϊ ϋϊȝ ´ϲϲ ŭϭμϊϲϓϋϲϊȝŰŪϊ ůŰϭ μϵŮϓ Ŭ (ΕϊĸϱŬ 4.6) ȼ ŭϓŬůŰϊƞŰϭŰŪ Űϊȝ ϱŰŪϊϲϓ ȣ μŸŰϊ ȝ ŸȝŰϊŰϊůŰϛ Ů ϊŬϭϲůŰϛ ϋϲμŬϊϲȝŰŪϊ Ŭ ƞ 18 ȣϛ 24 μϵȝŮϛ. ȼ μŰϊ ůϭ Űϭϛ ŭϓŬůŰϊƞŰϭŰϛ ´ Ůϓ ŬŰϭϓ ϲϊ ȝŰŪϊ ϋƞϊȣ ϋŬϊŰϭϛ μŮϓ ϊϲϛ Ŭ ƞŰϓ Űϊϭϛ Űϊ ȝ ŭϊŰϊ ϋϊȝ ŬϛŰϊ ȝ.



ΕϊĸϱŬ 4.6: ȥ ϕϭŪϊȢϊμϛϱŬ ŮϊŰϕϭϓ ȣ ůϕϛ ůŰŪ ϱŰŪϊϲϲϓι μŪŰŪ μŪϊϓ Ŷϛ ŭϊϓϓ ϋϊŬϊϛ.

Å Ėϛμ´ ϲϋϛμŮϓϵ ϱŰŪϊϲϲϓι μŪŰŪ (Shelf-Polishing Copolymer Paints): ȼŬ ϲϓι μŪŰŪ ŬϛŰϓ ŮϊŵϲϭϭůŬŪ Űϊ 1974. ΕŰŪ ϱŰŪϊϲϲϓι μŪŰŪ ŬϛŰϓ, Űϊ ƅϊϲϋŰƞϲ ´ ϊϲůŰϊůŰŪ ϲϭμϊϊŸ ůŰϊ ´ϲϋϛμŮϓ ȣϛ ϛ´ ƞůŰϓ ȣ μŬ. ȼ Ŭ ŮϊŰϕϭϓ ȣ ůϭ Űϊȝ ƅϊϲϋŰƞȝȣ Ŭ ƞ Űϭȝ Ů ϊŸȝŰϊŬ ƅŬŰϵϛ ´ ϊϲϋŬŰϊŰŪ Ŭ ƞ μϊŬ ϲϭμϊϊ ŬȝŰϊϓ Űϭϭ μŮ Űϊ ϭŬϋŬůϊϊƞ ȝŮƞ ϋŪŰϓ Ŭϭȝ ϲ´ ϲϊŬ ϲϊȝŰŪ ϱϓ ƞϋϛůϭ Űϊϲ ϲϭμϊϊϲϊ ŭŰϊμϲϊ ƅϊϲϋŰƞϲϲ-ϲ´ϲůŮϓι μŪŰϊϲ. Őŵϊ ϲϲϲ ϲϊȢϊμϲϱŬϊŰϲȝŰŪϊ ůŮ μϊŬ Űϊϊϊϊ Ů ϊŸȝŰϊŬ ϭ ϲ´ ϲϊŬ ŬȝŬŮ ȝϲȝŰŪϊ ŭϊŮ ϋι ϛ ϋŬ ´ ŮϓŮμ´ ƞŭϊŮ Űϭȝ ´ ϊϲůϋƞϋϭůϭ ϲϊ ϊȢϊμι ȝ. Β ϊϲϭμϛϱŬ ŮϊŰϕϭϓ ȣ ůϭϛ Űϭϛ ƅϊϲϋŰƞϲϲ ϲϲůŬϭϛϵŰŪ ϲŬμϭϋƞϛ ϋŬϭ ŭϊŸϊ ϋϊŬ ϵȣϵϛ Űϊȝ ϱŰŪϊϲϲϓ ȣ μŸŰϊ ȝ ϋϛμŬϲϊϲȝŰŪ Ŭ ƞ 5 ȣϛ 7 ϲϓ ƞȝϊŬ

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Ǖ ǂ ฆȡ ȝ Ǖฆȡ ǖǕȓ ȝ

Ƀ əǗǘǚďǗǖ ɞɠ ǚǗʠȝ ǗȝŋǕ ɔǗȝɖ µǗǗəəəɐ ǗɞǕɠ µɞǖ ǘɐ ɣɕǕəǗ ɞǘǕɞǗǗɦǗəǗȝǗəǚɞǗǗəɣ µɖ Ǘȝɜəŋɠ. ȷ ´ ŋ Ǘɖ ɣəəɖ µǕǖ əɣ Ǘɞ Ǘɞȝɜəɞəɞɔəŋ ´ ǖ ɞǘɞə Ǘȓ ȝ Ƀɇ ǕɞǗə ´ ɞəɨ ǚɨ ȝɖǕǗɞ ǘəŋǗə ǕəǗǖ ǗɣǗǗə Ǘ ŋ ´ ɞəəɞɨ ɠ ´ Ǘǖ ɣɔɞȝǗǗɠ. Ƀ ə Ƀɇ ǕɞǗəǚǗɖ ɔǕȝəɐ Ǘɞɠɠ µɞǖ ǘɐ Ǘȝɜəɣɠ Ǖฆȡ ǚǕɠ əǗəɖ Ǘȝɜəŋ Ǘɖ ǗɣǗɞɠɠ ´ ɞəəəǗə Ǘȝɣəɞɔ ǗǗ µǕ Ǘɞ ǗǚɞɠəǗə Ǘȝ ǗǕ ɞɖµŋ Ǘȓ ȝ ɠ ´ ɞəǗǗǗǚǗǗǗ ȝ R. ǘǕȝəɣ, ɞə Ǘǖ ə ɠ ´ ɞəǗǗǗǚǗɖµɣȝǗɠ Ƀɇ ´ Ǘǖ ɞɠǚǕɣɞɞɠȝ Ǘɖ µǕəǗəɨ ǗǕ ɖ Ǘȝɜəŋ ǗɖǗǗ Ǘ ´ ŋ ɞ ´ ɞəǗǘɐ ´ ɞǗǗµɞǖ ǘɐ

$RnSnX_{4-n}$ (ȶɞǗəǗɠ 4.3).

ȶɞǗəǗɠ 4.3: ǗǗȝǗǗɖǘŋǖ Ǘ ǘŋǚɖ ǘəǗ ǚǗŋµǗǗɞɠ µǕ ฆȡ ȝ Ƀɇ Ǖฆȡ ǚǕȓ ȝ ǚǗǗǖ ɞɠǖ Ǘɞɠɠ

OT	LD_{50} (mg kg^{-1})	OT	LD_{50} (mg kg^{-1})
Et_3SnOAc	4	Hex_3SnOAc	1000
Me_3SnOAc	9	$(Bu_3Sn)_2O$	150-234
Me_3SnCl	13	Bu_3SnOAc	380
Me_3SnOH	540	Bu_2SnCl_2	100
Me_2SnCl_2	74	$BuSnCl_3$	2140
$MeSnCl_3$	1370	Bu_4Sn	>4000
Ph_3SnOH	125	Oct_4Sn	50000

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[illegible] R_3SnX [illegible] R [illegible] (Bảng 4.4).

Bảng 4.4: [illegible] (R3SnX) [illegible] [52]

[illegible] (R) OT [illegible]	[illegible]
CH_3 ([illegible])	[illegible]
C_2H_5 ([illegible])	[illegible]
C_4H_9 ([illegible])	[illegible]
C_6H_5 ([illegible])	[illegible]
[illegible]-C_6H_{11} ([illegible])	[illegible]

[illegible] Et_3SnOAc [illegible] (oral LD_{50} rat=4 mg kg^{-1}). [illegible] R [illegible] PVC [illegible] TBT [illegible] 0,04±16 mg L^{-1} [illegible] DBT [illegible] MBT, [illegible]

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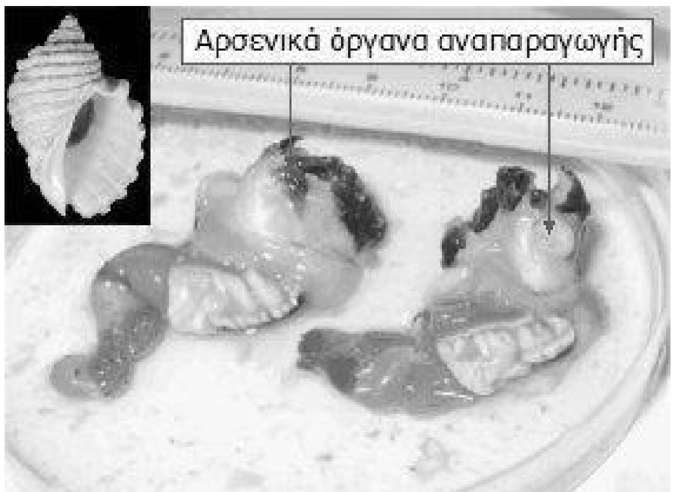
ɕg (MBT) ɔʂǓ ǘɕgģ gǚɉ ɧɓʂɕgģ ɕɉ ɔǓɕʂǚµɕɨ ģ µǗɉ ʂɣģ Ǔ ɧ Ɏəɔɖ əǓə 25 mg L^{-1} ɔʂǓ ǕǕ ɓǓəǘɖɉ ɷʂǓ. ȼ µɧəgɜǚɖ ǘɤɜ gɰɉ ɧɓʂɤɜ ugǔǕɖµɎǕɤɜ Ǔ ɧ ȼɕɒȼ əǓəȼPhT µ´ ɕɉ ǚɑɜǓ ´ ɉ ɕəǓəɣǚǚəǕǕ ǔʂɎǘɕɉ Ǔ ǚgµ´ ǘ µǓǕǕ ǚǘɕgģ ɕɉ ɔǓɕʂǚµɕɨ ģ ɕəɕ´ ɕɕɕəɣɕɕgɜ ´ ɉ ɕǚɓəɖɖǚ ȼǓ ´ Ǔɉ Ɏɔɤ ɔǓ ǘɕg ȼɕɒȼ ɕǓɉ Ǔəǘɖɉ ǚǘɖəǓɜ ɤģ ɕəǘɕɜʂəɧǕɉ Ǖģ ɕgǚǚģ ´ ɕg ɕ Ɏɜɖɉ ɤ´ ɕģ ǔʂɕɣǕǚgǚǚǚǘɕ ɖǓəɎǚǚʂ ´ Ǚɉ ʂɓɎəəɕɜ, Ǔɓɜɕɩ ɜǕǕģ ǘɖɜ ǘɕɜʂəɧǘɖǕɎ ǘɕgģ. H ɕɜǚɑǓ ǘɕɜʂəɧǘɖǕǕ (LD$_{50}$) ǘɕg TBT ǚǚgǔɎǘɕɕgģ ɕɉ ɔǓɕʂǚµɕɨ ģ ´ ɕʂəɕəǚə Ǔ´ ɧ <0,1 ɣɤ ģ 1800 µg kg^{-1}. ɆǕǕ ɕǚǗ Ǔəɧǔǚɉ µǓ, ɕ ȼɕɒȼ ǚ ʂǔɉ Ɏ ǚǘɕ µǚǕǕɓɕəʂǚµɧ ǘɕg Ca^{2+} µǚ Ǔ´ ɕǘɣəǚǚµǓ ǘɖɜ ǚǕǕǔʂǓəɛ ´ Ɏɕgɜǚɖ ǘɕg əǚɕɨ ǘɕgģ əǓəǘɕ ɖɎɜǓǘɕ Ǔ´ ɧ Ǔǚǘgɜʂǔ.



Ɇɕɛ µǓ 4.7: Ǔɖəgəɧ (Ǔɉ ʂǘǕɉ Ɏ) əǓəǓɉ ǚǚɕəɧ (ǔǚɕʂɎ) ɕǚǗ Ǔəɧǔǚɉ µɕ ´ ɕg Ǔɕɛəǚəǚǘɖɜ ɕµɎǔǓ ǬThais Orbitaǭ (ɕɤ ɉ ɷģ əɣəgǘ ɕɡ).

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[illegible] «imposex» [illegible] (TBT) [illegible] 4.7 [illegible] «imposex» [illegible] «imposex» [illegible] «intersex» [illegible] 150 [illegible] «imposex» [illegible]

[illegible] ng L^{-1}. [illegible] (TPhT) [illegible] O Tas [illegible] (guppies, reticulata Poecilia) [illegible] TPhT [illegible] TPhT [illegible] 2,2 mg g^{-1} [illegible] PhT [illegible] (TET) [illegible]

[illegible] DBT [illegible] TBT [illegible] TMT [illegible] TPh[illegible]OAc. [illegible] DMT [illegible] TMT [illegible]

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[illegible] TMT [illegible]

4.5 [illegible]

[illegible] PhT, [illegible] 4.8.

$$R_4Sn \rightarrow R_3SnX \rightarrow R_2SnX_2 \rightarrow RSnX_3 \rightarrow SnX_4$$

[illegible] 4.8: [illegible]

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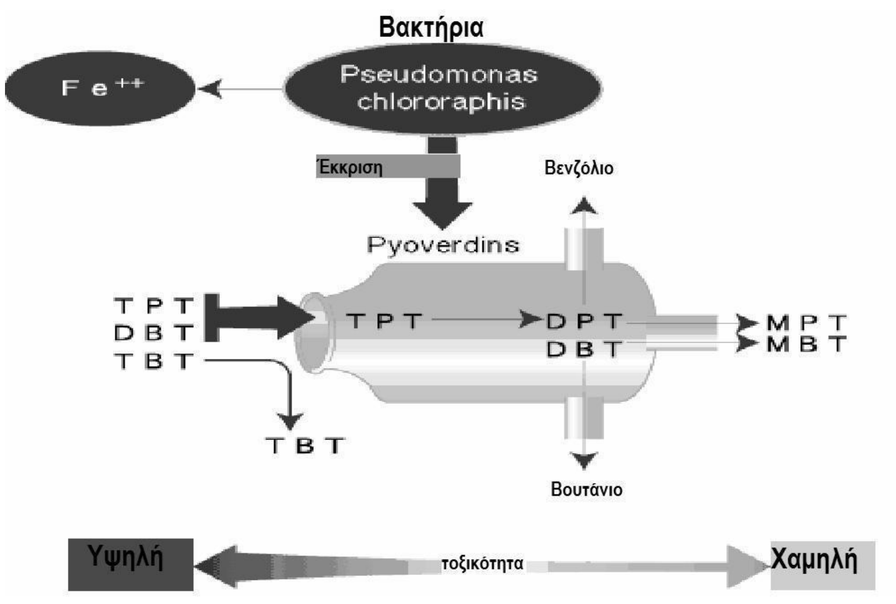
ɑɞɜ µ´ ɑɟ ůɒɜŬ ɑŬɟ ŬɘŰɖɟ ɞŰŰɑůŬɜ ůŰŰŭɞŬɘɶ µůɒ ůɖ Űɛg ɜɘŬŰɥůŰŰůɖɡ Ŭ´ ŋ Űɞ ɘŬŰŋɜ Űɛg ɘŬůůɞɜɟ ɑg. ȼ ŬŰŬŰɖ ůŰɖ Űɞɜ ɑɟ ɔŬɜɑɩ ɜ ɑµɣŭɞɜ g´ ɑɘŬŰɥůŰŰůɖɡ µ´ ɑɟ ůɒɜŬ ´ ɟ ɑɘɘɖɡůŬŬ ŋ ŭɜɥŰɑɟ ɑgɡ µɖɑŬɜɞůµɑɨ ɡ µŮɟ ɞɑɑŬ ŋ Űɛgɡ ɑ´ ɑɒɛgɡ ŮɒŬɘɑɘŬŋɘɛgɗɑɘ

ÅƗ´ Ůɟ ɞ ŭɖɡ (UV) ŬɘŰɒɑɓɑɘɑŬ. ȼ ŰɣŰŋɘgůɖ Űɛg ɖɘɜŬɘɑɨ ŰɣŰŋɡ Ŭ ɑŰŰɘɜŰɑɖɜ ´ ɞ ɔɟɐɔɑɟ ɖ ŭɞŬŭɞŬůɖŬ Ŭ ɑŭŋµɖůɖɡ ůŰɒ ɜŮ ŋ. Ƀ ŭŮŰµŋɡ Sn-C Ŭ ɑɟ ɟ ɑŰɣ µɥɟ ɑɡ Űɖɡ Ůɑɥɟ ɔŮŭɡ Űɛg ŰɣŰŋɡ, ɖ ɑ´ ɑɑŬ µ´ ɑɟ ůɒɜŬ ŮɒŬŬɟ ɘŰŰɐ ɔɞŬ ɜŬ ´ ɟ ɑɘŬɥůŮŭɥŮ´ Ŭůɖ Űɛg ŭŮŰµɑɨ ŬgŰɒɨ . Ƀɘ Ůɟ ɞŰŬɑgɘɑɘŬůůŮɟ ɞɥɡ ɘŬɘŮɟ ɞgɘɘɑŬŬɜɑɘŬůůŮɟ ɞɥɡ Ůɒɩ ůŮɡ ŭŮŬ´ ɩ ɜŰŰɘ´ ɞ ɔɟɐɔɑɟ Ŭ g´ ŋ Űɖɜ UV ŬɘŰɒɑɓɑɘŬ ůŮůɑɥůɖ µŮŰŰ´ Ŭɟ ɣɔɣɔŬ Űɜ ɜ Ůɟ ɞɑgŰɘɑɘŬůůŮɟ ɞɩ ɜ Ůɩ ůŰɜ ɜ.

Å ɖɞɑɘɑɔɞɶ ŭɥů´ Ŭůɖ. ʐ Ůɟ ɞɣ ɓŬɘŰɐɟ ɞŬ ŋ´ ɣɡ: Pseudomonas aeruginosa, Pseudomonas putida C ɘŬɘ Alcaligenes faecalis ɥɑɑɜ Űɖɜ ɞŬɜŋɖŰŬ ɜŬ ´ ɟ ɑɘŬɘɑɨ ɜ Ŭ ɑŭŋµɖůɖ Űɜ Ƀȼ Ůɩ ůŰɜ ŬɜɣɑɜŬ µŮŰɞɡ ´ Ůɟ ɞɓŬɘɑɑɜŰɞɥɡ ůgɜɖɶɘŮɡ (Ƀɑɶ µŬ 4.9). Ʌ´ ɑůɖɡ ŰŰ µɞɟ ɑɣɘɑɖ ŮɒŬɘ ŭgɜŰŰŋ ɜŬ ´ ɟ ɑɘŬɥůɑgɜ Ŭ ɑŭŋµɖůɖ Űɛg ȼɖȼ ůŮDBT g´ ɑ ɑɟ ɞůµɥɜŮɡ ůgɜɖɶɘŮɡ.

Åɟ ɖµɞɶ ŭɥů´ Ŭůɖ. Ƀ ŭŮŰµŋɡ Sn-C µ´ ɑɟ ůɒɜŬ ŭɞŬů´ ŬůŰŰɑɘŬɘŬ ŋ ɖɘŮɘŮɟ ɑɜŋŰɞŬ ɘŬɘŬ ŋ ´ gɟ ɖɜŋŰɞŬ ŬɜŰɓɟ ŬůŰɐɟ ɞŬ.



Ƀɑɶ µŬ 4.9: ɑɞŬŭɞŬůɖŬ Ŭ ɑŭŋµɖůɖɡ Ƀȼ Ŭ ŋ Űɖɜ ɥɜɣ ůɖ ñpyoverdinò´ ɑɡ Ůɞɟ ɑŰŰɘ Ŭ ŋ Űɞ ɓŬɘŰɐɟ ɞ (Pseudomonas chlororaphis) [70].

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[illegible] (CH3I) [illegible] Sn(II) [illegible] (Pseudomonas bacteria) [illegible]

4.5.1 [illegible]

[illegible] 4.5 [illegible]

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Ǘɞg ɇɕɇ ůŮŭэŦűɞɟ Ůʃ Ǘɞ´ ɞɗŮũɗŮʃ (ɘЯµŸɜэǗ, µŬɟ ɑŮʃ, ǓɘǗɞɔɟ Ǔµµɏʃ ɘ.Ǔ.)

[illegible]	ɇ µŮɟ . ɶŬɵµ.	ɄŸɢɞʃ ҿɐµ. [cm]	ɇɕɇ [ng Sn g¯ 1]
ɗŬɘŰɵɐ ɘŬɘɗɧɟ ŮɵŬ ŪŸɘŬũůŬ	1997ï 1998	-	33ï 6,970
ɆŰɞɘɢɧɘµɖ, ɘЯµŸɜэŬ, Ɇɞgɖŭɗ Ŭ	2007	0ï 2	27ï 533
ɗŬɟ ɘŮɶ ɜɖ, ɘЯµŸɜɇ Ƚů´ Ǔɜɗ Ŭ	2002	0ï 5	98ï 4,702
ʐ Ůũɧɔ Ůɵɞʃ, ɘЯµŸɜэŬ, µŬɟ ɑŮʃ	2004	0ï 10	37ï 4,402
ʐ Ŭɟ ɑŮʃ, ɘЯµŸɜэŬ, ȽŰŬɘɗŬ	2003	0ï 2	43ï 39,300
Ⱦɧɢɘʐɞµ´ Ÿɇ ɘЯµŸɜэŬ, Ƚɜŭɗ Ŭ	2000ï 2002	-	2ï 6,894
Ⱦɧɘ´ ɞʃ ɃŰũɞɨ ɘɇ ȽŬ´ ɤ ɜɗ Ŭ	2005	-	8ï 5,740
ʂ Яµɏɜ Ůʃ, ǓɘŰɞɔɟ Ǔµµɐʃ ɇŬɵŸɜ	2001ï 2004	-	1ï 3,505
Ⱦɞgɑůɘ Ŭɜ Ǘ µŬɟ ɑŬ, ɟ gů Ǘɟ Ǔɘɗ Ŭ	-	0ï 20	90ï 3,587
ʂ ЯµŸɜɘũɜŰŸɜůɘ, Ʉɞɘɤ ɜɗ Ŭ	2008	0ï 5	13ï 15,780
ũɜŰɑэŬ, ɘЯµŸɜɇ Ʉɞɘɤ ɜɗ Ŭ	2008	0-5	8ï 1,910

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з ůǗǺ ďŬǝҮůůǝ ´ Ǖ ǝҮǝǝз Ŭ ôǕďǗŬ µǕ´ бǝǝi ǥ ǝŬǝ ŬǥǗ ůǕ ůǥзǔǥŬůµђ µǕ Ǘз Ǘзǝђ ǝŬǝ Ǘз Ǘǥ ǕŬ ǕŬǕ µбǝ Ǘŕз Ǖз ůǕŕз ŬǥǗ з ǔǝŬǝǝǕǗ µǕҮǝ ђǝǝ Ǖ Ǖǥзι з ´ бǥ ұǥǥз ǝŬǝǝǝǗǝ ǝŬ Ǘз Ŭзбзǥů Ǘŕз Ȼǿ ůǕ ǝҮзŬ, Ǖǝбǝұǥ ´ бǗµǝ з, ďҮǝŬůůŬ, ǝµзǕ, ŬǝǗǝ Ŭµµұǥ. ȾǗ ǥǔŬǗђ ´ Ǖ ǝҮǝǝз, Ǘ ǔǝҮǝ Ŭ Ǘǔď ǝзǝ з Ȼǿ: TBT^{+}, DBT^{2+}, MBT^{3+} ǝŬǝ ǥǔұǕ ɣ з: TBTOH, DBTOH, MBTOH, TBTNO$_3$, TBTCl ǝ.Ǘǝ., µ´ б Ǖ зŬ ǔǗ бi зǗǝ Ŭ´ ђ ǔǥзҮµǗ ŬзǗǝǝŬǝǥ ǝŬǗђзǗŕз ǝŬǝ ǔǥзҮµǗ Coulomb. ȾǕ pH µǗi 4 ǝŬǝ 7, б DBT ´ ǝů бǗҮǗǝ ůǗ бďµŬ ůǕ µǕŬǝi Ǘ б ƀŬďµђ Ŭ´ ђ Ǘз TBT. ǝ ´ ђ Ǘз Ҷǝǝď µǕǝҮ ůǕ pH< 7, бǝ ďǗǝҮ ǗбǗµұзǕǥ Ȼǿ ǝǥǝŬбi з ůǗ ǥǔŬǗђ ǔǝҮǝǥµŬ ǝŬǝ ǥ´ ҮбǕǝ µǝŬ ďǝǕǗбůǗǗǝ ұǝǝď µǗi Ǘŕз ďǗǝҮ ǗбǗµұзɣз Ȼǿ µбǝ з ǝŬǝ Ǘǥ Ŭзď ǝҮ ǗбǗµұзďǥ µǕǗǝǝǝǥ Ǖ ǝҮзǕǗǥ Ǘŕз ǔǝҮǗбɣз Ǖ ǝŬзǕǝŬǝι з ´ Ǘɣ µҮǗŕз. ȾǕpH 8, ď ůǥзбұзǕŬ Ǘŕз Ǖι ůǕŕз ŬǥǗ з µǕǗ бďµŬ ŬзǗůǗұǗǗǝ TBT > DBT, ǝђбɣ Ǘǥ ǥǔ бǗбƀǝǝǥ ǝђǗǗǥ Ǘŕз Ǖι ůǕŕз ŬǥǗ з [79]. Ƕ ђůǗŬǗ ǔǝŬ ǝǗ ďďǝǕ ǝǗǗµұзď ´ Ǖ бǥůǝŬ OT ǝŬǝ ůǗ ǥǔҮǗǝб ´ Ǖ ǝҮǝǝз Ǘǥ ȺǝǝҮǔŬǥ. ȾǗ ďŬǝŬůůǝђ зǕ ђ бǝ ůǥзǝǕǗι ůǕǥ Ǘŕз ǿďǿ, DBT ǝŬǝ MBT ǝǥµŬбзǗз Ŭ´ ђ <2 ұɣǥ 70, 159 ǝŬǝ 19 ng L^{-1}, ŬзǗůǗǝǝŬ. ȾǗ ´ бǗҮµǝŬ ǝŬǝůǗǥ ǝµзǕǥ бǝůǥзǝǕǗι ůǕǥ Ǘŕз Ȼǿ ´ бǥ Ŭзǝз Ǘǝз ǝǗз бŬµďǝұǥ Ǖι ǥɣďǝұǥ ůǥзǝǕǗι ůǕǥ < 384, 76 ǝŬǝ 68 ng L^{-1} ǝŬ Ǘ TBT, DBT ǝŬǝ MBT ŬзǗůǗǝǝŬ, Ŭззǝ Ǘǝз ůǕ ǕůǕ бђµǕŬ Ŭ´ ђбǝďǗ µбҮǔɣз Ǖ ǕǝǕǝŬůǕǥ ǥǝι з Ŭ´ бǝǝŕз. ȾǗ ´ Ǖ ǝҮǝǝз Ǘǥ ǕǔҮǗбǥǥ, ď ǝǝďǗђǗǗ Ǘǥ Sn µ´ б Ǖ зŬ Ǖ ď ǗǗůǗǗŬ´ ђ Ǘз Ŭ´ бǝ ђǗďůǝ Ǘǥ ůǗз Ǖ ǝҮзǕǗ Ǘǥ ǕǔҮǗбǥǥ ǝŬǝ Ŭ´ ђ Ǘ ǝǥďµђ Ŭ´ бǔђµďůďǥ Ǘŕз Ȼǿ ´ бǥ ǕǝŬǝǝŬǗ µǝбǥ Ŭ´ ђ Ǘǥ ǗǥůǝұǥǝŬǝ бďµǝұǥ ǝђǗǗǥ ђ´ ɣǥ: ď ´ бǝǝђǗǗ ǝŬǝ ď бďµǝǝ ůi ůǗůď. ɀ Ǖ ǝұǥ Ǖι ůǕǥ ђ´ ɣǥ Ǘǥ ǿďǿ µ´ б Ǖ зŬ ǕǝŬǝ´ ǝ ůǗďǕ ұǥ Ŭ´ ђ ŬǥǗұǥ Ǘǥ ǿPhT ђǗз ǔǝбǗǗǥǗi з ůǗ ұǔŬǗ бǥ ǥ´ ђ Ǘǥ ǔǝǕǥ´ Ǖ ǝŬǝǝзǗǝұǥ ůǥзďǝǕǥ. ÔбǕǝŬ бǔǗбǗђǗǗǥ´ Ǖ ǝůђǗ ǕǥǗб ұǥ Ŭзǝз Ǘ зǗǝ ůǥзǝǕǗι ůǕǥ Ǘŕз Ȼǿ Ǖι ůǕŕз µǕǗз Ŭǝђǝбǥďď ůǕҮ TPhT< DPhT < TBT < MPhT < DBT < MBT. ǿб ǝǕбзђǥ ŬǥǗђ ůǥзǔǥҮůǗǝǕŬ´ ђ Ǘǥǥ ǕǕǥзďǗұǥ µǕǗз µǕҮǝď ůǗďǕ ђǗǗ Ǘŕз Ȼǿ Ǖι ůǕŕз ď б´ бŬ ǝǗз ŬзǗǕ ђǗɣǥ ŬзҮǝзď µǕǗ ƀŬďµђ ǥ´ бǝǗǗůǗůďǥ ǝŬǝµǕǗ Ǘiůď Ǘŕз бǝŬзǝι з бµҮǔɣз Ǘŕз Ȼǿ Ǖι ůǕŕз, ǝŬǝď б´ бŬ ǔǝǝǥµŬбзǗз Ŭ´ ђ 24 µұǕǥ ǝŬ Ǘз ǿPhT ұɣǥ ǝŬǝ 220 µұǕǥ ǝŬ Ǘз MBT. ǿŬ бǕŬǝǗǕǗǝҮ Ǘǥ ǕǔҮǗбǥǥ ђ´ ɣǥ: pǿ, ´ Ǖ ǝǗǝђǗǗ бǝŬзǝǥ i ǝďǥ, µǗǝǝђǗǗ, ǔǥзŬµǝђ бзǕɣůďǥ ǝŬǝ µǝǕ бǝŬзǝµбα´ Ŭбǥз ǝŬďбǝǗǝђ ǝђǝб ůǗз ǔǝŬů´ бҮ Ǘŕз Ȼǿ Ǖι ůǕŕз ůǗ ұǔŬǗбǥ. ǔǝŬ Ǘз ǿďǿ ұбǕǝŬ бǔǗбǗђǗ´ ŬǕŬµұзǕǝǝŬ µŬǝ i бǕбзǝђ ǔǝҮůǗďµŬ ůǗ ұǔŬǗбǥ µǕбǝђзб ďµǗǕǝǥ ɕɣǝǥ Ǘǥ 39 µұǕǥ, Ǖι ǝŬ Ǘз ǿPhT ǕǝŬǝ ůǕǥ 6±1 µұǕǥ. ǝ ´ ђ ǕǝǕǝŬǝ´ ұ Ŭ ǔǝҮǗбǥ бǝµďбŬзǝµбαŬ бǔђµďůďǥ ǝŬµƀҮзбǥз бι Ǖ ŬұǗǝι ůǗ зŬ ´ ŬҮǝбзǗǝ´ ǝбǗзǗ Ŭ´ бǔђµďůďǥ Ǘǥ MBT ǝŬǝDBT Ŭ´ ђ Ǘз TBT ǝŬǝɀ PhT ǝŬǝǗǥ DPhT Ŭ´ ђ Ǘз TPhT. ȿђǝɣ Ǘǥ ǕǥǕŬǥ бǝůďǥ Ǘŕз µǥǝďǗǝǗђзɣз ůǕǥ ǝŬǝǝұǝǕǥ ´ ŬǗǥ, бŬбǕђǗǥǗɣз, ǝǥбǝi , бǝȻǿ Ǖι ůǕǥ ǝǥǝɣǥ б ǿďǿ ǝŬǝǿPhT Ŭ´ бǗǝi з ůďµŬзǗђ ǝбǔǥзб ǝŬ Ǘз

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[illegible] PhT, [illegible] [84]. [illegible] DBT [illegible] 17,1 ng g^{-1}, 18,8 ng g^{-1}, 7,8 ng g^{-1} [illegible] 13,0 ng g^{-1} ([illegible]) [illegible] TBT, DBT, MBT [illegible] TPhT, [illegible] [84]. [illegible] TBT [illegible] 0,91 µg kg^{-1} [illegible] 2,21 µg kg^{-1} [illegible]

[illegible] OT [illegible] (4.10). [illegible] OT [illegible] PVC ([illegible]) [illegible] PVC.

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[illegible] 4.10: [illegible] [52].

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ǖɜ ɞǅ ɐůɖ Ǘɨ ɜ ɞǅ ɔŬɜɞəŬůůɚǗǗǅ ɚɑɩ ɜ Ůɚɩ ůŮɨ ɜ

ŬŭəƳǘɞǅ ɞgǵ ɗŬəƳůůɚgǵ ɞǅ ɔŬɜɚůµɞɨ ǵ (µɨ ŭɚŬ, ȹůǗ ŬəŬ) ůŮ ůdŬ Ǘɨ ɜ Ƀǿ Ůɚɩ ůŮɨ ɜ ůǗɞ ɗŬəƳůůɚ ´ Ůǅ ɚƃƳəəɞɜ ɞŭɐɔɖůŬɜ Ǘǵ ũŬəəɚɵǵ Ŭǅ ɞɵǵ Ǘɞ 1982 ůǖɜ Ŭ´ ŬƃȹǅŮǵůɖ ɞǅ ɐůɖǵ gǘŬəɞǅ ɤµƳǗɨ ɜ ůŮ ´ əɞŬ əƳǗɨ Ǘɨ ɜ 25 µɵǗǅ ɤ ɜ. ǿŬ µɵǗǅ Ŭ ŬgǗƳ Ů ŮəǗƳɗɖəŬɜ əŬəůǗɞ ǿ ɜ ɤ µɵɜɞ ɗŬǘůɞɚǗɞ Ǘɞ 1986 ȹ´ ɞg əŬəɗŮɩ´ ɞǗɖəŮɵɜŬ ȹǅ ɚɞ ´ ɞɚȹǘɖǗǵ ɔɚŬ Ǘɞɜ ǿɗɚǿ (20 ng L[-1]) ůǗŬ µŬəƳəɚŬ Ůµ´ ɞǅ ɚɞɞǵ əŬǗǗɜƳəɤ ůɖǵ. ȿȹɔɤ ȹµɤ ǵ Ǘɖǵ µŮƃƳəɖǵ ǗɞɜɚɞȹǘɖǗǵ Ǘɞ ȹǅ ɚɞ ŬgǗȹ əŬǗɵƃɖəŮ10 ǘɞǅ ɵǵ əƳǗɨ Ŭµɵůɤ ǵ Ǘɞɜ Ů ȹµŮɞɞ ɞǅ ȹɜɞ. ǿɞ 1989 ɖ ȺgǅɤŬ´ Ŭɚɐɐ Ŏɜɤ ůɖ Ůɞɵŭɤ ůŮǗǖɜ ɞŭɖɔɖŬ 89/677/ȺɃȺ ůɨ µǘɤ ɜŬ µŮǗǖɜ ɞ´ ɞɖŬ ŭŮɞ Ů ɚǗǅ ɵ´ ǗǗŬəɖ ɞǅ ɐůɖ Ƀǿ ɤǵ ŭǅ ŬůǗɚɩ ɜ ɞgůɚ ɜ ůŮ´ Ŭǅ ŬůəŬgƳůµŬǗǗ ´ ɞg ´ ǅ ɞɞǅ ɞɞɜǗəɜŬ ɞǅ ɖůɚµɞ´ ɞɚɖɖɞɨ ɜ ɔɚŬ ƃŬǘɐ gǘƳəɤ ɜ: (Ŭ) ůəŬǘɩ ɜ µŮŮɚɤ ǗǗǅ ɚɞȹ ɞəɞȹ µɐəɞǵ (ȹ´ ɤ ǵ ɞǅ ɞǗǗŬəůǗɞ ´ ǅ ȹǗǵ´ ɞ ISO 8666) < 25 m, (ƃ) ůŮ əəɤ ƃɞɨ ǵ, ´ əɤ Ǘɐǅ Ůǵ,ŭɞɞǗǵŬ əŬɗɩ ǵ əŬə ůŮ əƳɗŮ ŮƃəŬǗƳůǗǗůɖ ɐ Ůɚɞ´ əɚůµȹ ɚɞɖgɞəŬəəɚǅ ɔŮɚ ɜ əŬɞɞůǗ ŬəɞəŬəəɚǅ ɔŮɚ ɜ (ɔ) ůŮ ŮƃəŬǗǗůǗƳůǗǵ ɐ Ůɚɞ´ əɚůµɞɨ ǵ ƃgɖɚůµɵɜɞgǵ ɐ ɖµɚƃgɖɚůµɵɜɞgǵ ůǗɞ ɜǗǅ ȹ. ǿɞɜ ɞŭɚɞ ɞǅ ȹɜɞ ɖ ǅ gůǗǅ Ŭəɞ əŬəɖ ŁŬ ɤ ɜɞŬ Ŭ´ ŬƃȹǅŮǵůŬɜ Ǘɖ ɞǅ ɐůɖ gǘŬəɞǅ ɤµƳǗɨ ɜ µŮ ǿɗɚǿ. ǿ Ŭ´ ŬƃȹǅŮǵůɖ Ŭgǘɐ gɚɞɗŮǗɐɖɖəŮ Ŭǅ ɔȹǗǗǅ Ŭ əŬə Ŭ´ ȹ ƳəəŮǵ ɞɩ ǅ Ůǵ (ǅ gůǗǅ ɗŬ, Ɇɞgɖŭɗŭ). Ɉ´ ɐǅ ɞŬɜ ȹµɤ ǵ ůŮ µŮǅ ɚɵǵ ɞɩ ǅ Ůǵ əŬə ɞǅ ɚůµɵɜŮǵ ŮɚŬɚ ɵůŮǵ ŬɜƳəɞɔŬ µŮǗɞ µɐəɞǵ Ǘɞg ´ əɞɞg əŬə Ǘɞ ɞɩ ǅ ɞ ´ ɞg ɵ´ əŮǗ ǿɞ 2001 ɞ ɚɚŮɗɜɐǵ Ƀǅ ɔŬɜɚůµȹǵ ŬƳəŬůůŬǵ Ƶ Ƀ (International Maritime Organization,) ´ ǅ ȹǗɚŮ(AFS 2001) Ǘǖɜ Ŭ´ ŬƃȹǅŮǵůɖ Ǘǖǵ ɞǅ ɐůɖǵ Ǘɞg ǿɗɚǿ ŭɚǗɜɩ ǵ Ŭ´ ȹ Ǘɞ 2003, ɩ ůǗŮŬ´ ȹ Ǘɞ 2008 ɜŬ µǖɜ g´ Ƴǅ ɞǗɞ´ əɵɞɜ ǿɗɚǿ ůǗŬ ɨ ǘŬəŬ Ǘɨ ɜ ´ əɞɞɤ ɜ. Ƀ ůǗȹɞɞǵ Ǘǖǵ ȺgǅɤŬ´ Ŭɚɐɐǵ Ŏɜɤ ůɖǵ µŮ Ǘɞɜ ȺŬɜɞɜɚůµȹ 782/2003 «ǅ´ ŬƃȹǅŮǵůɖ Ƀǿ ůŮ gǘŬəɞǅ ɩ µŬǗǗ ´ əɞɞɤ ɜ» ŮɚŬə ɜŬ´ Ůǅ ɚǅ ɞǗə Ǘǵ Ů ɵ Ǘ ůǗǵ ůǗɞ ɗŬəƳůůɚ ´ Ůǅ ɚƃƳəəɞɜ əŬə Ǘɖ Ŭɜɖǅ ɩ ´ ɚɖ gɔŮŬ. Ƀ əŬɜɞɜɚůµȹǵ ɚɞɨ ŮəǗȹůɞ ɔɚŬ ǗŬ ´ əɞŬ əɞɚɞǗɚɐǵ ůɖµŬɗǵ ȹůɞ əŬəɔɚŬ ǗŬ ´ əɞŬ ŬɜŮƳǅ Ǘɖǘɞg ůɖµŬɗǵ ´ ɞg əŬǗǗ´ əɵɞɜ ɐ Ŭ´ ɞ´ əɵɞɜ Ŭ´ ȹ əɞɚɞǗɚȹ əɚµƳɜə ÝůǗȹůɞ ɖ ´ əɐǅ ɖǵ ǗɩŬǅ µɞɔɐ Ǘɞg əŬɜɞɜɚůµɞɨ ɗŬ ɔɚȹǗɜ Ǘɩȹůɞɜ ɣ ɖǘɚɚǗɗŬ´ ȹ 25 əǅ ƳǗɖ ´ ɞg ŬɜǗɚǅ ɞůɤ ´ Ů ɞgɜ Ǘɞ 25% Ǘɞg ´ ŬəȹůµɞɞɞŮµ´ ɞǅ ɚɞɞɨ ůǗȹəɞg. ǿ ´ əɐǅ ɖǵ Ŭ´ ŬƃȹǅŮǵůɖ ȹµɤ ǵ ŮɚŭɚəƳ ůǗŬ ´ əɞɖŬ ɚɨ Ů Ŭ´ ȹ Ŭǅ ɞɵǵ Ǘɞg 2008 (782/2003 Ŭ´ ȹǘ.) ŬɜŮƳǅ ǗɖǗŬ ǗɖǵŬ´ ȹǘŬůɖǵ AFS 2001. ǅ əȹµɖ əŬǗɵǗǗɜŮǗɞɜ ǿɗɚǿ ůɨ µǘɤ ɜŬ µŮǗǖɜ Ŭ´ ȹǘŬůɖ 2455/2001/EK ɤǵ Ǘ ɞ´ ɞ´ ɞɖůɖ Ǘɖǵ 2000/60/ȺȺ ůǗǵ Ů ɚɞɞŭgɜŮǵ ɞgůɗŮǵ (priority hazardous substances). Ƀ ɄŬɔəȹůµɚɞǵ Ƀǅ ɔŬɜɚůµȹǵ ɈɔɗŬǵ (WHO, 1992) əŬɖ Ɉ´ ɖǅ ŮǗɗŬ Ʉǅ ɞůǗǗůɗŬǵ Ǘɞg ɄŮǅ ɚƃƳəəɞɜǗɞǵ Ǘɨ ɜ ǿɄǅ (EPA, 1997) ´ ǅ ɞǗǗɚɞɞɜ ɤǵ ǅ ɜŮɚǗɐ ǿµǗǅ ɐůɚŬ ɚȹůɖ (Tolerable Daily Intake, TDI) ɔɚŬ ɜŬ µǖɜ ´ Ŭǅ ɞgůɚůǗɞɨ ɜ Ǘɞɜɚɵǵ Ů ɚǅ ƳůǗǵ ůǗɞɜ Ƴɜɖǅ ɤ´ ɞ, ǗŬ 0,25 µg kg[-1] ƃƳǅ ɞgǵ ůɨ µŬǗɞǵ / ɖµɵǅ Ŭ ɔɚŬ Ǘɞɜ ǿɗɚǿ, DBT, TPhT, DOT [84]. ɆŬɜ ůgµ´ əɖǅ ɤ µŬǗɚɐ ɞŭɖɔɖŬ Ǘɖǵ 2009/425/ȺC ´ ɚɞ əƳǗɨ ŬɜŬǘɵǅ ɞɜǗəɞ ´ ɚɞ ´ ǅ ȹůǘŬǗǗǵ ɜɞµɞɗŮǗɚɵǵ ŭɚŬǗɜŮɚǵ ɔɚŬ Ǘɞɜ ´ Ůǅ ɚɞǅ ɚůµȹ ɞǅ ɐůɖǵ Ǘɨ ɜ Ƀǿ, ɞəɞ´ ɞɖǵ ɗɵǗɞgɜ ɵɜŬ Ŭɜɩ ǗǗǗɞ ȹǅ ɚɞ ůgɔəɵɜǗǅ ɤ ůɖǵ (0,1% m/m ɤǵ Sn) ůǗŬ ŭɚƳǘɞǅ Ŭ ´ ǅ ɞǗȹɜǗŬ. Ƀə ɞǅ ɞɜɚɵǵ ´ ǅ ɞɗŮůɖɗǵ ɔɚŬ Ǘǖɜ ǗɩŬǅ µɞɔɐ Ǘɞgǵ ´ Ůǅ ɚɵɞɜǗǗəůǗɞɜ ŬəȹəɞgɗɞɄɞŬəŬ 4.6 [85]

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ɞɛɡɜ ŰŰďŮůɐ ďŬ ŰŰďɕɨ ɜ ůŮŰŰŬ̦ µɕɔɐ ɔɘŬ Űɚɜ ΄ Ů̦ ɘɕ̦ ɘůµɦ

ȼ µŮ̦ . 1/6/ 2010	Ƀȼ: ȼri-Ƀȼ, ȼdɸ, ȼPhT	̳ ɫɔɘůŰď Ƀgɔɘ. 0,1% w/w Sn
	ȻŰɦɕɛɠ	Ʉɕ ΄ ̦ ɕɰɦɜŰŬ/ŰŰŬ̦ µɕɔɫɠ
ÿ ɘŬ ŰŬ Űɑŭď ΄ ɕg ɘgɘɘɕűɕ̦ ɕɨ ɜ ůŰɚ Ů̦µ΄ ɦ̦ ɘ	Å ɟ ̦ ɐůď ɓɘɘŰɦɜɤ ɜ[1] ůŮ΄ ̦ ɕɰɦɜŰŬ ɫɘɤ ůŰɚɦűŬɜŰɕɡ̦ ɔɑŰɠ Å ̳ ď ŬɘɘŮ̦ ɔɘɎ µŬɚɘɎ̦ ɘŬ Å Ƀɦɘŭɠ ΄ Ŭ ɕgŰŰɘ ɜ	
ȼ µŮ̦ . 1/1/2012	Dioctyl-tin (DOT)	̳ ɫɔɘůŰď Ƀgɔɘ. 0,1% w/w Sn
	ȻŰɦɕɛɠ	Ʉɕ ΄ ̦ ɕɰɦɜŰŬ/ŰŰŬ̦ µɕɔɫɠ
Ʉɑŭď ΄ ɕg ΄ ̦ ɕµďďŮ ŰŰɘŰɚ Ů̦ɡ̦ ɨ ɘɕɘɦ, gűɎůµŬŰŬ ΄ ɕg ɫ̦ ɕɕɜŰɘ ůŮ Ů Űűɐ µŮ Űɚ ŭɫ̦ µŬ, ɔɎɜŰɘŬ, g΄ ɕŭɐµŬŰŬ ΄ ɕg ɫ̦ ɕɕɜŰɘůŮ Ů Űűɐ µŮ ŭɫ̦ µŬ, ΄ ̦ ɕɰɦɜŰŬ Ů ɘɎɘgɣďɠ Űɚɕɤ ɜ-΄ ŬŰɤ µɎŰɤ ɜ, ɓ̦ ŰűɘɎ Űɑŭď ű̦ ɕɜŰɑŭŬɠ, Űɑŭď gɔɘŮɚɐɠ, ΄ Ŭɑɘɫɠ ΄ ɎɜŮɠ, ΄ ̦ ɕɰɦɜŰŬ ůɘɘɕɜɩ ɜ	Å Ʉɘŭɠ ΄ ɩ ůŮɚɠ ůŮµ΄ ɘɨ ɕŮɠ Å ũɎɜŰɘŬ PVC Å ȻŬɚŭɎɘɘŬ Ŭ ɦ PVC Å PVC ΄ ̦ ɕɰɦɜŰŬ, Å Ʉɑŭď gɔɘŮɚɐɠ, ΄ Ŭɑɘɫɠ ΄ ɎɜŮɠ Å Ʉɕ ɕɘŮɠ, Ŭgűɦ-Űů ΄ ɑŮɠ ɘ.Űɘ.	
ȼ µŮ̦ . 1/1/2012	DBT	̳ ɫɔɘůŰď Ƀgɔɘ. 0,1% w/w Sn
	ȻŰɦɕɛɠ	Ʉɕ ΄ ̦ ɕɰɦɜŰŬ/ŰŰŬ̦ µɕɔɫɠ
	ɋɘɎűɕ̦ Ŭ Űɑŭď	Å PVC ΄ ̦ ɕɰɦɜŰŬ Űɠ ΄ ɕ΄ ɕɑůďɠ, ɎɘɘŬ PVC gɘɘɎ Å ̦ ű̦ ɕɑ΄ ɕɘgɕg̦ ŰďɎɜďɠ, µŮɘɎɜɘŬ Ůɘŭɠ ΄ ɩ ůŮɤ ɠ, ůɦɘŭɠ g΄ ɕŭďµɎŰɤ ɜ Å Ʉɕɘgůŭ Ű̦ ɘɎ Űɑŭď Űɠ ΄ ɕ΄ ɕɑůďɠ ɘŬɘ Ů ɘɕ̦ ɘůµɎŰɤ ɜ
ȼ µŮ̦ . 1/1/2015	DBT	̳ ɫɔɘůŰď Ƀgɔɘ. 0,1% w/w Sn
	ȻŰɦɕɛɠ	Ʉɕ ΄ ̦ ɕɰɦɜŰŬ/ŰŰŬ̦ µɕɔɫɠ
Ʉɑŭď ɔŮɚɘɐɠ ɕ̦ ɐůŮɤ ɠ, ɘɦɘŭɠ Ůɚɦɠ ɘŬɘ ŭɨ ɕ	Å ɫɦɘŭɠ ɘŬɘgɘɘɎ ɔɘŬ	

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ʃ ⁊Ŭɘ

ȼŰŮɓŬɜɞ´ ɞɑʠůɗ

Ů ɘɕɟ ɗůµŬŰŬ ´ ɞɡ ´ Ůɟ ɘɏɕɡɜ DBT ɤɠ ɘŬŰŬɘɨ Űɗ,

Å Ⱥ´ ɘɕɟ ɗůµŬŰŬ ůŮŭɘɎűɕɟ Ŭ ´ ɟ ɞɥɲɜŰŬ

µŬɘŬɘɎ ´ ɟ ɞɥɲɜŰŬ PVC ůŮ ůɡɜŭɡŬůµɧ µŮ

Å ⁊ɞɡűɩ µŬŰŬ, ɘŬɜɎɘɕŬ ɘŬɘɤ ŭɑɤ ɜ

ůɘɘɑɟ ɧ PVC, ɘŬŰŰůɘŮɡɎůµŬŰŬ Ů ɘɘŬɘɡµµɏɜŬ

Å Ō´ ɘ ɘŬ ŮɘɤŰŮɟ ɘɘɕɨ ɕɩ ɟ ɞɡ, ŰɏɜŰŮɠ

µŮPVC ´ ɞɡ ´ Ůɟ ɘɏɕŮɘDBT ɤɠ ůŰŬɗŮɟ ɞ´ ɞɘɑʠŰɐ

[1] ȼ ɕɟ ɐůɗ Űɤ ɜ Ƀȼ ůŮɓɘɘŰɲɜŬ ɏɕŮɘŬ Ŭɓɕɟ ŮɡŰŰɗůŰɗɜ Ⱥɡɟ ɤ ´ Ŭɥɐ ɏɜɤ ůɗ

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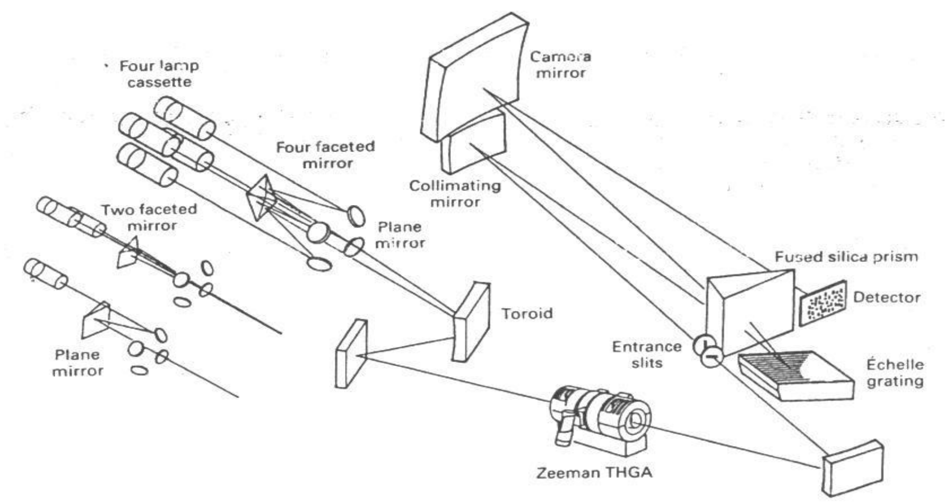
ፓȂū ȷ ȿȷ ꝉƁ 5

ȽꝉΛȷ ȥ ȷ ǿꝉƮ ¢ ʊƁΛȂꝉ

5.1 Ɓȷ ɔǓɜɞɘɜɔǓ

ǿɞ ´ ɞɘǥůǗɞɕǗǓɘɧ ǘǓůɛǓǗɧɛǗǰɞ ǓǗɛɕɘɛɠ Ǔ ɞȷ ȷ ɧǘɖůɖǥ Perkin Elmer SIMAA 6000 ɕȷ ɖůɛɞ´ ɞɕɖɖɘǗɔɘǓ Ǘɖ ůǥɔɘǗɘȷ ɕɣɜɖ ɛǗɘɣǗɖ. ǿɞ SIMAA 6000 Ǘɖǥ Perkin-Elmer, ǗɞǓɘǗɞ ´ ȷ ɩ Ǘɞ ´ ɞɘǥůǗɞɕǗǓɘɧ ǘǓůɛǓǗɧɛǗǰɞ ǓǗɛɕɘɛɠ Ǔ ɞȷ ȷ ɧǘɖůɖǥ, ɛǗ Ǘɞůɤ ɛǓǗɤɛɣɜɞ ɣɜǓ ɞ´ Ǘɘɧ ůɨ ůǗɖɛǓ ǗǗǰ ǓǗɤȷ ɕɞɨ ´ ɞɘǥɞȷ ɤ ɛɎǗɞȷ Ǔ Echelle (Tetrahedral Echelle Polychromator) (ůɕɛɛǓ 5.1) ɕǓɜɧ ɜǓ ǗɘǗɘǗɘǗɖǥǗɧɕȷ ɞɜɞǥǥ ´ ȷ ɞůǔɕȷ ɕůɛɞɨ ǥ 2 ɣɤǥ 4 ůǗɞɕǗɤ ɜ ɘǓɘɣɜǓɜ Ǔɜɕɜǘǥǘɛ ůǗǰ ǗɎǥ ɘǓǗɤůǗǗůɖǥ (solid-state detector). Ȃ´ ɖůɖǥ ´ Ǘ ɕɘǓɛɓɎɜǗɘǗ ɕɛɘɖ Ǘ ɖǘȷ Ǔůɖ Zeeman ɔɘǓ ǔɕɧȷ ɖɤ ůɖ ǥ´ ɞɓɎɖȷ ɞǥ ɘǓɘ ǗɘɎȷ ůɕǓ ɖǗȷ ɛǓɕɧɛǗɞɞ ǘɞɨ ȷ ɜɞ ɛǗ ´ ǥȷ ɞɘǥǗɘɎ ɘǓɘǥɛɛɣɜɖ ´ ɘǓǗǘɧȷ ɛǓ. Ɓ Ǘɞ´ ɘůɛɧǥ ǓǥǗɧǥ ´ ȷ ɞůǘɣȷ Ǘɘ ´ ȷ ɞůǔɕȷ ɕůɛɧ ɛɣɔɕůǗɞǥ Ǔȷ ɕɖɛɞɨ ǔǗɘɛɎǗɤ ɜ, ɕǓɛɖɘɧ ɘɧůǗɞǥ ǓɜɎ ǓɜɎɘǥůɖ, ǗɞǓɘ ǗɘɣǥǓɞǓɘǥǗɘɣǥ ǗǘǓȷ ɛɞɔɣǥ, Ǔɘȷ ɕɛ Ǔ´ ɞǗǗɘɣůɛǓǗǗ, Ǘ ɘɞɘɖ ǗɞɕɘǗɤ ůɖ, ůǥɛɛɧȷ ǘɤ ůɖ ɛǗɘȷ ǓǗɘɎ ɛ ɎɘɘǓ Ǘǘɤ ǗǗȷ ɕɎ ȷ ǥɖɛɕůǗɘɎ ´ ȷ ɤ Ǘɧɘɞɘɘ ɘǓɘǗɣɘɞǥ´ ɞɧǗɖǗǗ ɘǓɘǓɜɕ´ ɕůǗǓ [17].



ȾɕɛɛǓ 5.1: Ɓ´ Ǘɘɧ ůɨ ůǗɖɛǓ SIMAA 6000 [17].

Ɓɘ ǗɞǓɘ ǗɘɣǥǗǘǓȷ ɛɞɔɣǥ ´ ɞǥ Ǘ ɕǗɔɞɎɜɞɜǗǗɘɛǗǗɞ SIMAA 6000 ɞǘǗɘɞɜǗǗɘůǗɞɜ ůǥɜǔǥǓůɛɧ Ǘɞǥ Ǘ ɕɛɘɞǥǥ ǘǓɞɧɛǗɞǥ Zeeman ɘǓɘ Ǘɞǥ ǘɞɨ ȷ ɜɞǥ ǗɕɜɞɘɜɔǓǥ THGA ɛǗ Ǘɞǥǥ ɔɜɤ ůǗɛǥ Ǘ ɖǘɞůɖǥ ´ ɞɘǥɞȷ ɤ ɛɎǗɞȷ Ǔ Echelle ɘǓɘǓɜɕɜǘǥǘɛ ůǗǰ ǗɎǥ ɘǓǗɤůǗǗůɖǥ. ǿɞ ɞ´ Ǘɘɧ ůɨ ůǗɖɛǓ ɛǗ Ǘɞɜ ´ ǓǗǗɞǗǗȷ ɕůɛɣɜɞ ǗǗǰ ǓǗɤȷ ɕɧ ´ ɞɘǥɞȷ ɤ ɛɎǗɞȷ Ǔ Echelle Ǘ ɕǗ ɣ´ ǗɘǗɜ ´ ȷ ɞůǔɕȷ ɕůɛɧ ɣɤǥ ɘǓɘ ǗǗůɎȷ ɤ ɜ ůǗɞɕǗɤ ɜ ǗǗǥǗɧɕȷ ɞɜǓ, ɛǗɘ ɜɞɜǗǗǥ ůɖɛǓɜǗɘɎ Ǘɜ ɕȷ ɧɜɞ ǓɜɎɘǥůɖ. ȾǥɜǔǥɏɕǗɘǥɣ ɖɘɛ ǔɕǗů´ ɞȷ Ɏ ɘǓɘǘɤ ǗɞɓɞɘǓ ɛǗǗɞǓɘ ǗǘɘɛǥŕɞɧǗɖǗǗǥ ǓɜɎɘɘǓůɖ ůǗɘɎɖǗůɖɛǗɞ Ǘɞǥ Ǘ ɘ ɣǔɞǥ

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ŭ̃ʂŬů ΄ Ůų ŮŰŬəŭʂůŭʂЧůŰŰŰ ɞ΄ ђŰŮђəŬ ŰŬ ɛɐəɖ ǝɨ ɛŬŰɞɠ ŰŬəůŬɛʂŬ΄ Ůų ʂɕɞɐ ɛɏŰɉ ɖůɖɠ ɛɐəɞɠɠ Ŭ΄ ђ 3 ɏɤɠ 6 cm [17].

Ɇɕɐɛ Ŭ 5.2: ū ŬůɛŬŰђɛŰɉ ɞ Perkin Elmer SIMAA 6000

ũʂŬ Űɖɜ Ůəɞɨ ǝʂůɖ Űɤ ɜ ɞɉ ɔŬɜɞəŬůůʂŰŰɉ ʂɑ ɜ Ŭ ђ ŰŬ ŭŰɕɛŬŰŰ ɞɉ ɖůʂɕ ɞ΄ ɞəɞɖɖəŮɞ ŰɞɨɈ ɜɞɠ ɛʂɉ ɞəɡɛ ЧŰɤ ɜ MARS XPress Űɖɠ ŰŰʂɉ ŮɔŰɠ CEM. ɉ ɡŰђɠ Ŭ΄ ɞŰŮəŮŰŰəŬ΄ ђ:

Ɇɨ ůŰɖɛ Ŭ΄ Ůɔɞɡ ɛʂɉ ɞəɡɛ ЧŰɤ ɜ ɛɏɔʂůŰɖɠ ʂůɞɨ ɞɠ 1600 Watts ± 15%

- Ɑɖŭ ʂŬəђ ɡ΄ ɞəɞɔʂůŰɐ ʂŬɜђ ɔʂŬ 100 ΄ ɉ ɞɔɉ Чɛɛ ŬŰŰ
- ɄŮɉ ʂŭʂəђ ɐ ůɡɜŮɕɏɠ ΄ Ůɉ ʂůŰɉ ɞŭʂəђ ůɨ ůŰɖɛ Ŭ
- Ɇɨ ůŰɖɛ Ŭ ŬůŭŬəŮŰɠ ɔʂŬ Űʂɠ Űɉ Ůʂɠ ΄ ђɉ Űŭɠ əŬəɏɜŬ ђɉ ɔŬɜɞ ΄ Ŭɉ Ŭəɞəɨ ɖɖůɖɠ Űɤ ɜ Ůə΄ ɞɛ΄ ɩ ɜ ɛʂɉ ɞəɡɛ ЧŰɤ ɜ, ɔʂŬ ΄ ɉ ђəɖɣ ɖ, ђŰɜ ɖ ΄ ђɉ ŰŬ ŮɜŬəŬɜɞʂŰɐ

Ɇɕɐɛ Ŭ 5.3 Ƀ ŭɞɨ ɉ ɜɞɠ ɛʂɉ ɞəɡɛ ЧŰɤ ɜ MARS XPress

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ƏŰß gɣ ɖǝɐǥ ŬßŬǝgŰǝɐǥ ǝŬɗŬɈ ɧŰɖŰǥ (Suprapur Grade, Merck).

ɇŬ ´ ɟ ɧŰǥ´ Ŭ ŭǝŬǝɨ εŬŰ ´ ŬɈ ŬǜǝŬǥɎǜŰɖǝŬß εŮ ǝŬŰɎǝǝɖǝɖ ŬɈ Ŭɑ ǜɖ εŮ Űßǝǝgɧǝǝ ɏŰǝɩ ǜŰŮ ɜŬ ´ ɟ ɞǝɨ ´ ŰǜǝŭεŬ ´ ŬɈ ŬǝŬŰɗɐǝɖǥ ǜgɔǝɏɜŰɈ ɤǜɖǥ 10 mg/L ǝŬǝǜŰɖ ǜgɜɏɕŮǝŬ ŬɈ Ŭɑ ǜɖ εŮ ŮɐɎɜǝ ɩ ǜŰŮɜŬ ´ ɟ ɞǝɨ ɣ ŮǝŰǝǝɐ ǜgɔǝɏɜŰɈ ɤǜɖ 200 εg/L.

Ʌ´ ɑǜɖǥ Ű ǜǝŮ ɖ ´ ɞg ɕɈ ɖǜɛɞ´ ɞǝɗɖǝŬß ɐŰß ɔgɎǝǝŬ.

ɟ ɜŬǝgŰǝɧŰɈ Ŭ Ű Ŭß Űǝ ɟ Ŭǜ Ŭǝɟ ǝŬ ´ ɞg ɕɈ ɖǜɛɞ´ ɞǝɗɖǝŬß ŮɐŬǝŰ ´ ŬɈ ŬǝɎŰɤ :

- Ʉɟ ɧŰǥ´ ɞ ŭǝɎǝgεŬ Ű ɞɞɨ Űgǝǝ-ǝŬǜǜǝŰɈ ɞǥ (TBT) ´ ŮɈ ǝǜǝŰǝɧŰɖŰǥ 200 εg/L
- Ʉɟ ɧŰǥ´ ɞ ŭǝɎǝgεŬ Ű ǝŰŬɐgǝǝ-ǝŬǜǜɖŰɈ ɞǥ (TPT) ´ ŮɈ ǝǜǝŰǝɧŰɖŰǥ 200 εg/L
- Ʉɟ ɧŰǥ´ ɞ ŭǝɎǝgεŬ ŭǝɓɞɨ Űgǝǝ-ǝŬǜǜɖŰɈ ɞǥ (DBT) ´ ŮɈ ǝǜǝŰǝɧŰɖŰǥ 200 εg/L
- Ʉɟ ɧŰǥ´ ɞ ŭǝɎǝgεŬ ŭǝúŬɐgǝǝ-ǝŬǜǜǝŰɈ ɞǥ (DPT)´ ŮɈ ǝǜǝŰǝɧŰɖŰǥ 200 εg/L
- Ʉɟ ɧŰǥ´ ɞ ŭǝɎǝgεŬ εɞɜɞɓɞɨ Űgǝǝ-ǝŬǜǜɖŰɈ ɞǥ (MBT) ´ ŮɈ ǝǜǝŰǝɧŰɖŰǥ 200 εg/L
- Ʉɟ ɧŰǥ´ ɞ ŭǝɎǝgεŬ εɞɜɞűŬɐgǝǝ-ǝŬǜǜɖŰɈ ɞǥ (MPT) ´ ŮɈ ǝǜǝŰǝɧŰɖŰǥ 200 εg/L
- Ʉgǝɜɧ ɜǝŰɈ ǝɧ ɞɜɨ (65% v/v) (Suprapur grade, Merck, Germany),
- Ɉ´ ŮɈ ɞɜŮǝǝ Űɞg gŭɈ ɞɔɧɜɞg (30% v/v) (Suprapur grade, Merck, Germany)
- ÿ ǝɞǝ ɞǝ ŰɈ ɞ´ ɞ´ ɞǝɖŰɏǥ ´ ɞg ɕɈ ɖǜɛɞ´ ɞǝɗɖǝŬß (Au,Pd,Mg,Sm,Os,Tc,Zr,Gd,Tm,Ir,Rh) ɐŰß ´ ŮɈ ǝǜǝŰǝɧŰɖŰǥ 1000 εg/L
- Ɉ´ ŮɈ ǝɎɗŬɈ ɞ ɜŮɈ ɧ (MilliQ water, Millipore, Bedford, MA, USA)
- ɇɞǝɞgɧǝǝ 99,5% (Merck)
- ɅɜɎɜǝ 99,5% (Carlo Erba Reagens)
- ɄŬɓɧεɞɈ űɞ ɞɜǝɧ ɞɜɨ 100% (Merck)
- NaCl (Merck)

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5.3.1 [illegible]

[illegible] Au, Pd, Mg, Sm, Ir, Rh , Zr, Tm. [illegible] Re [illegible] Au. [illegible] 1000 mg/L [illegible] 5 [illegible] 5 [illegible] 1200-500 °C [illegible] 2400-1900 °C [illegible]

[illegible] 5.1: [illegible] Au [illegible] 5 [illegible]

[illegible]	[illegible] (°C)	[illegible] (°C)	[illegible] (pg)
TPhT	600	2300	455,4
TBT	700	2400	975,1
DPhT	1100	2200	410,3
DBT	600	2400	824,4
MPhT	900	2200	3300
MBT	600	2400	3300

[illegible] Tpyr=600 [illegible] Tatm=2400, [illegible]

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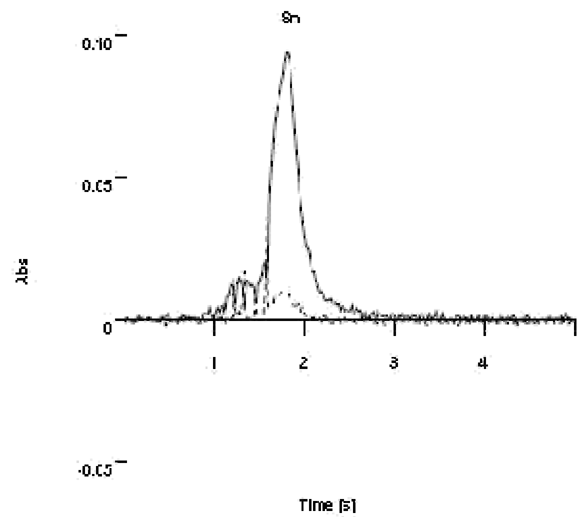
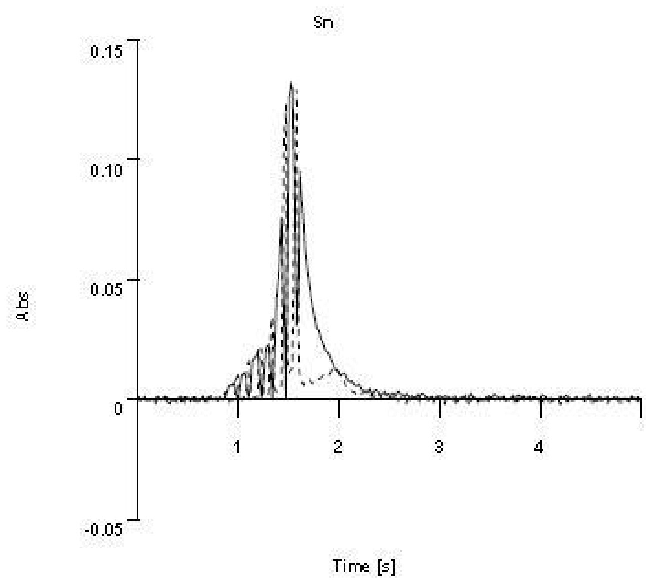


ɆɃɑɛŬ 5.4: ȽŬɛ΄ ɨ ɘɖ Ŭ΄ ɞɟ ɟ ɧűɖůɖɠ ɔɘŬ DBT ůɡɔɘɇɜŲ ɤ ůɖɠ 200 ɛg/L ůŮɛɖ ɓɇɘŰůŰɠ ɗŮ ɛɞɘɟ Ŭůɖůɠ Tpyr=600/Tat=2400



ɆɃɑɛŬ 5.5: ȽŬɛ΄ ɨ ɘɖ Ŭ΄ ɞɟ ɟ ɧűɖůɖɠ ɔɘŬ DPhT ůɡɔɘɇɜŲ ɤ ůɖɠ 200 ɛg/L ůŮɛɖ ɓɇɘŰůŰɠ ɗŮ ɛɞɘɟ Ŭůɖůɠ Tpyr=600/Tat=2400

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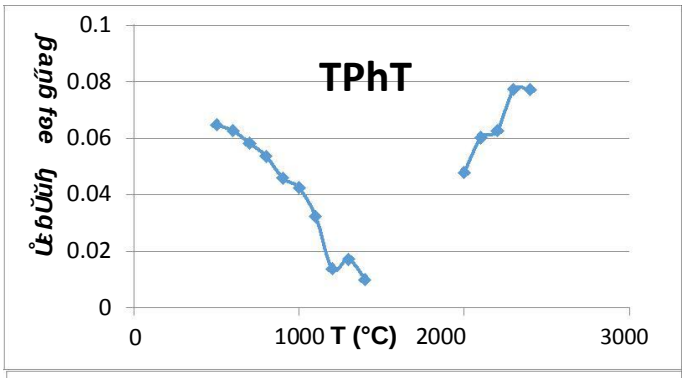

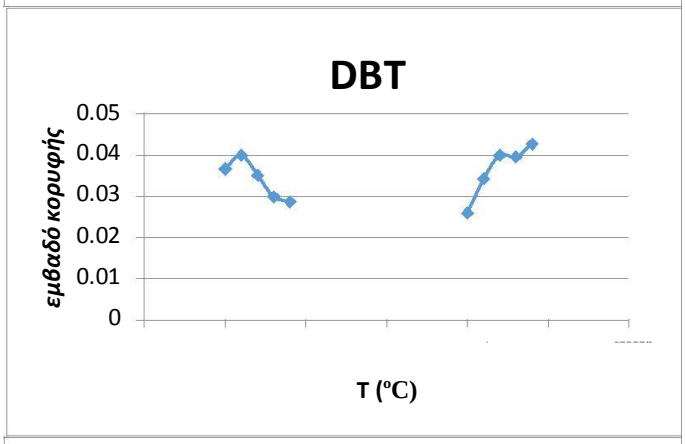

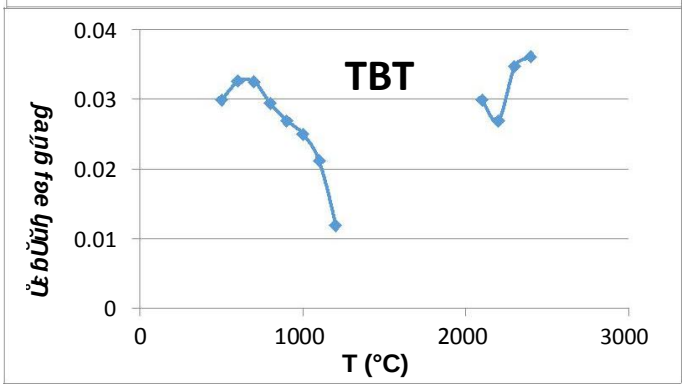

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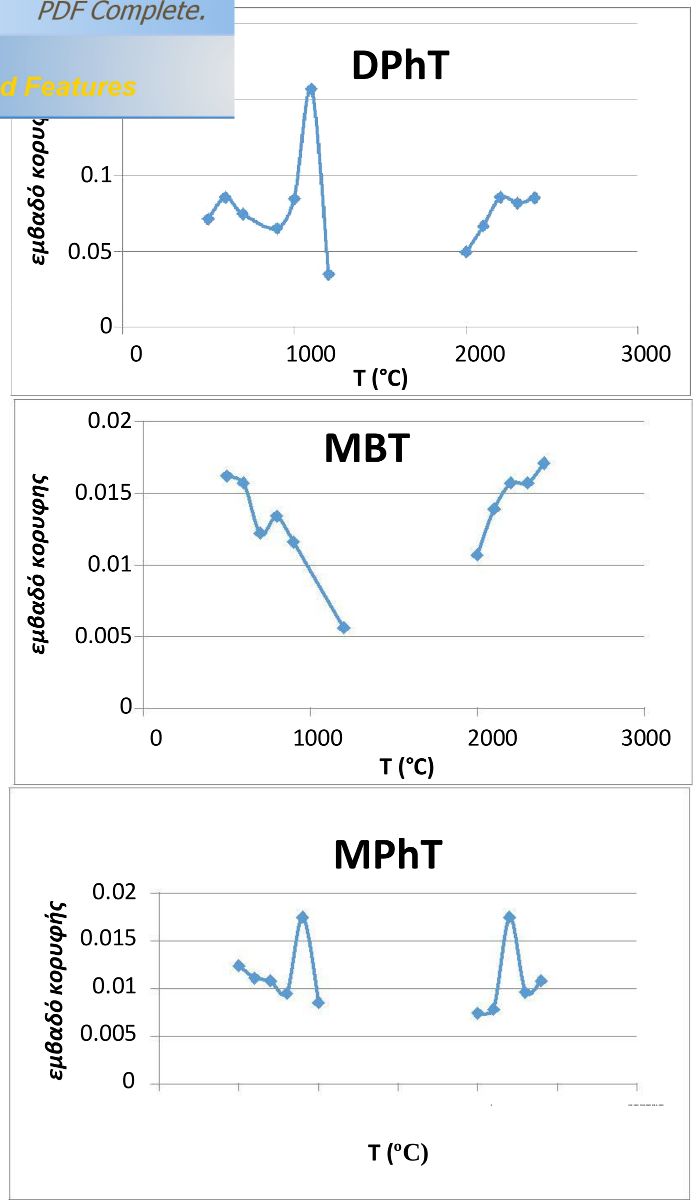

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ɞɺʼẸɕ Sm ɛ٣ɕǙǵ 5 ɛɡ. ȼ ǘɞǕǔɞǕǘȡǕ ˊ ɞɡ ǕəɞəɞɡɗɐɗɖəǗ ʇ ɧəɡǘɖǵ ˊ ɞɡ əɡɛǕɞɞɜǕǕɜ Ǖ ɧ 1200-500 °C əǕə ɔɞǕ ɖǖ ɛɞəʇ Ǖǘɖǵ Ǖɞɛɛɞ ɞɖʇǘɖǵ ˊ ɞɡ əɡɛǕɞɞɜǕǕɜ Ǖ ɧ 2400-1900 °C Ǘəɐǘɖɖǘǔɜ Ǖ ɞʇ ʇ ɞǘɐǘǔɞǵ əǕə ɔɞǕ ǘɞǵ ɣɜə ɞʇ ɔǕɜɞəǕǘǘɞǕǕʇ ɞɣǵ Ǘɜɩ ǘǗɞǵ. ɆǕɖ ǘɡɜɣɕǗɞǕ Ǘ ɞɣɕɖɖəǕɜ ɞə ɓɣəǕɞǘǕǵ ɖǕʇ ɛɞəʇ Ǖǘɖǵ ɔɞǕ ə٣ɖǗɛɞǕ ɞʇ ɔǕɜɞəǕǘǘɞǕǕʇ ɞɐ ɣɜɤ ǘɖ. ɆǕɜ ˊ Ǖʇ Ǖə٣Ǖɤ ˊ ɞǕəǕ ˊ Ǖʇ ǕǘɖǗɜǕǕəɞə ɓɣəǕɞǘǕǵ ɖǕʇ ɛɞəʇ Ǖǘɖǵ ˊ ɡʇ ɧəɡǘɖǵ əǕəǕɐɛɞ ˊ ɞɖʇǘɖǵ ɔɞǕ ə٣ɖǗɛɞǕ Ǖ ɧ Ǘɞǵ ɞʇ ɔǕɜɞəǕǘǘɞǕǕʇ ɞɣǵ Ǘɜɩ ǘǗɞǵ əǕɖɩ ǵ əǕə ǗɜǕǗɞǐɞ٣ ǘɨ ɞ əǕɛ ˊ ɨ əǗǵ Ǖ ɞʇ ʇ ɧǘɖǘɖǵ ǘǕ ɛɖ ɓɣəǕɞǘǕǵ ɖǕʇ ɛɞəʇ Ǖǘɖǵ ˊ ɡʇ ɧəɡǘɖǵ əǕəǕɐɛɞ ˊ ɞɖʇǘɖǵ ɔɞǕ ǘɨ ɞ ɞʇ ɔǕɜɞəəǕǘǘɞǕǕʇ ɞɣǵ Ǘɜɩ ǘǗɞǵ.

ǕɑɞǕəǕǵ 5.2: ɞɣəǕɞǘǕǵ ɖǕʇ ɛɞəʇ Ǖǘɖǵ ˊ ɡʇ ɧəɡǘɖǵ/ǕǕɛɛɞ ˊ ɞɖʇǘɖǵ ɛǗǕʇ ɞ ˊ ɞ ˊ ɞɕɺʼẸ Sm

ɃɅũɉ ʔɃȾɉ ɆɆɇɆɅɆȾȼ ɅʔqɆȼ	**ŪɅɅɀ ɃȾɅɉ Ɇɉ ɄɈɅɃȿɈɆȼɆ (°C)**	**ŪɅɅɀ ɃȾɅɉ Ɇɉ ɉȼɃɀ ɃɄɃɆȼɆȼɆ (°C)**	**ɉ ɉ Ʌɉ ȾȼȼɅɆȼɆȾȼ ɀ ɉ Ȼɉ (pg)**
TPhT	500	1900	252,0
TBT	1000	1900	335,9
DPhT	800	2000	198,8
DBT	700	2000	183,0
MPhT	1000	2200	561,4
MBT	800	1900	386,8

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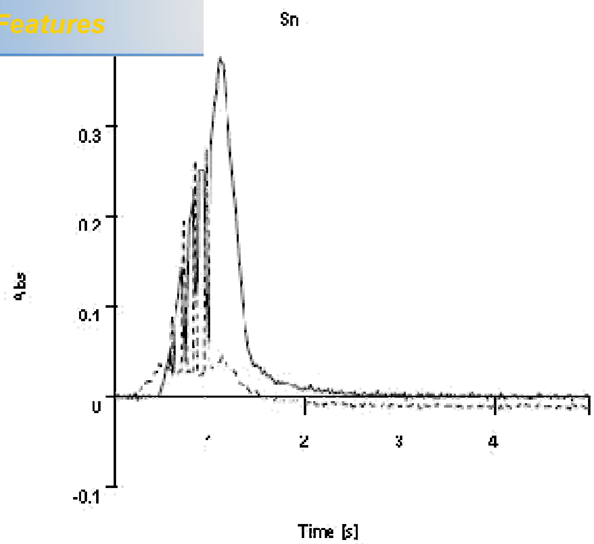
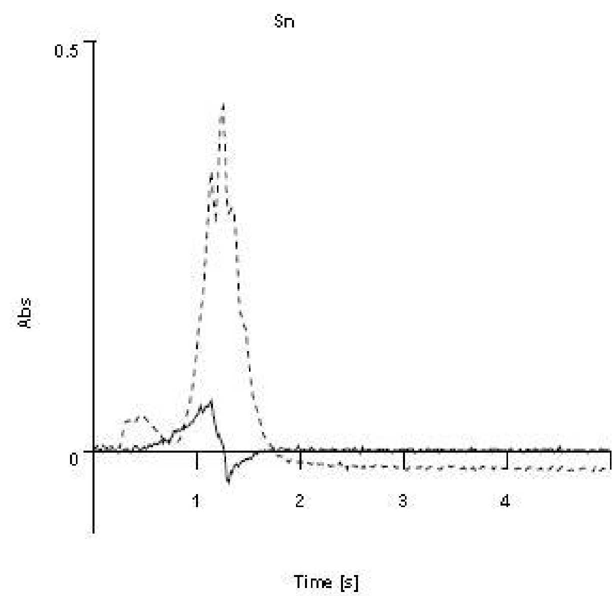


Ɇcɐɛ Ŭ 5.7: ⁄Ŭɛ´ ɨ əɋ Ŭ´ ɞɟ ɟ ɧűɋůɋɠ ɔɘŬ DPhT ůɡɔəɏɜŲ ɤ ůɋɠ 200 ɛg/L ůŮɛɋ ɓɏəŰɵůŰɠ ɗŮɟ ɛɞəɟ Ŭůɗůɠ
Tpyr=1000/Tat=2200



Ɇcɐɛ Ŭ 5.8: ⁄Ŭɛ´ ɨ əɋ Ŭ´ ɞɟ ɟ ɧűɋůɋɠ ɔɘŬ MPhT ůɡɔəɏɜŲ ɤ ůɋɠ 200 ɛg/L ůŮɛɋ ɓɏəŰɵůŰɠ ɗŮɟ ɛɞəɟ Ŭůɗůɠ
Tpyr=1000/Tat=2200

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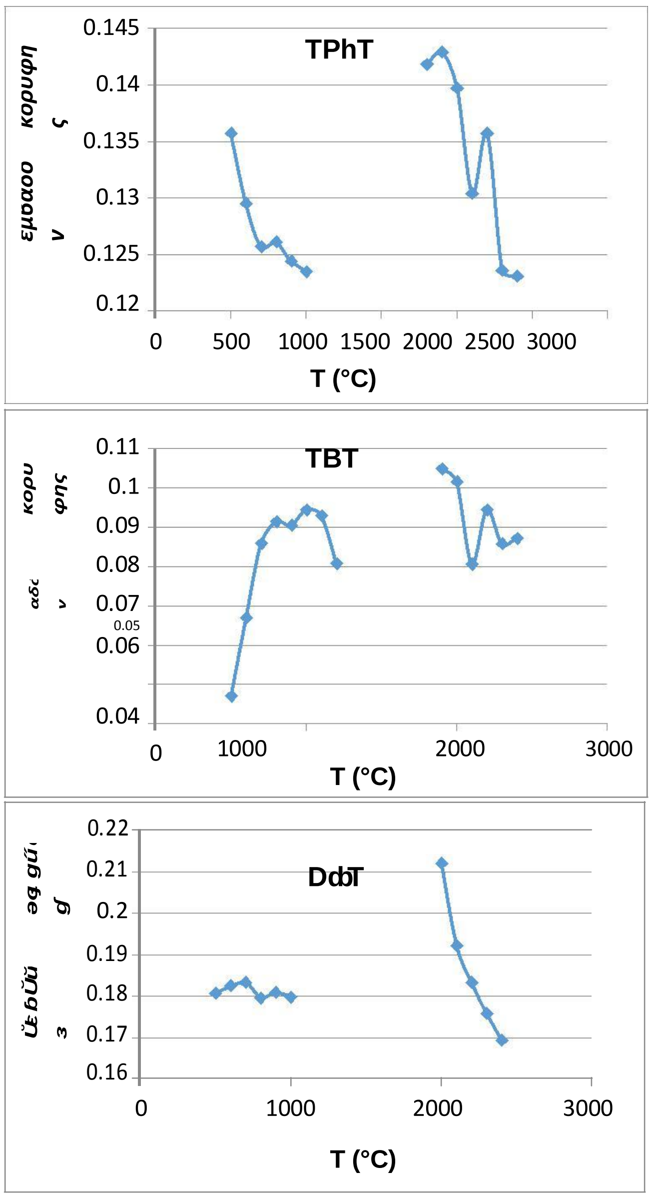
ŰŰɘŰŰ ŭɘŬɔ Ŭεε ϒŰŰ ´ gɟ ɧǝgůɖɖ/ŬŰɞεɞ´ ɞɖůɖɖ ǝŬɘɔɘŬ Ŭɞ
ɏɜɘɞɟ ɔŬɞɞǝŬůůɘŰŰɟ ɘɏɖ Ŭɞι ůŬɞ ůgɜŬɟ Ŭŭůŭɘŭɞg Ŭεɓŭŭɞɨ ǝɞɟ gűɐɖ εŮŲɟ ɞ´ ɞ´ ɞɖŰ Sm εϒɞŬɖ 5 εg.



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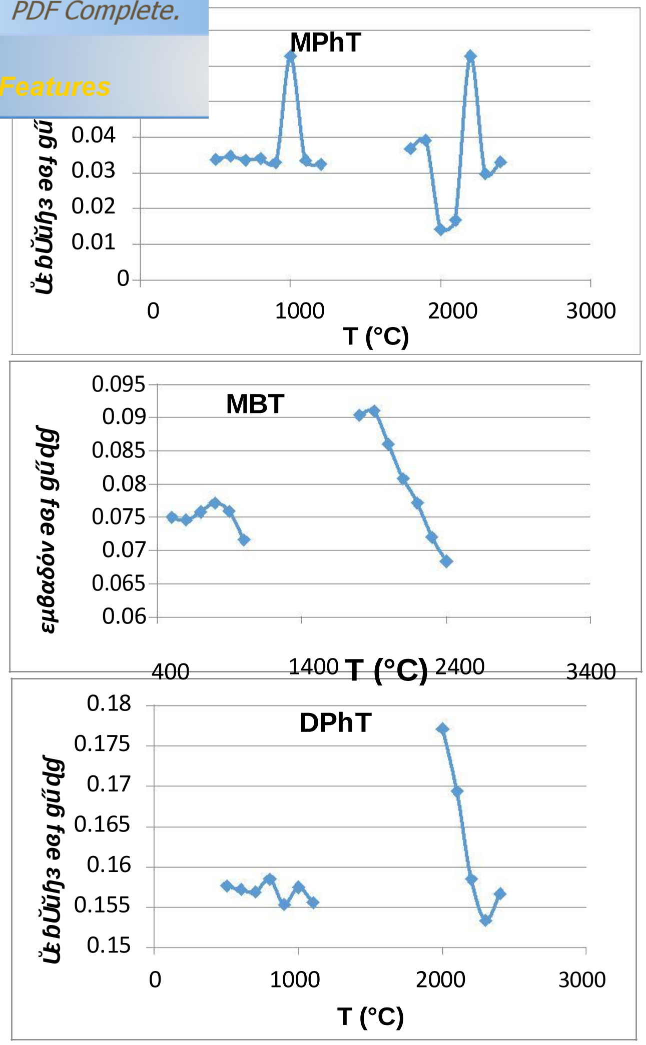

Ɇɢɐεῦ 5.9: ɊɑŬɓɟ ɎεεŬŰŨ ɗŲ εɞɘɟ Ŭůɗǖɠ ůɡɜŬɟ Űɐůůɘűε ɓŬŭɞɨ ɘɞɟ ɡűɐɠ ɔɘŬ Űɜɜ Ųɞ´ ɞ´ ɞɘɖɰɐ Sm εɎɕŬɠ 5 εɡ

ȷ ´ ɧ ɧɘŬ ŰŨ ´ Ųɟ Ű Ɏɜɤ űŬɑůŰŨɘ ɧŰɘ Ůɜɩ Űɜ Sm Ŭɡɜ Ɏɜ Ůɘ Űɖɜ ůɡŬɘůɗɖůɗŬ ɘŬɘ ŭɑůɘ εɘɘɟ ɏɠ ɞŬɟ ŬɘŰɖɟ ɘůŰɘɏɠ εŬɕůɠ Ůɜ Űɜɨ Űɜɘɠ ɞɘ ɓɏɘŰɘůŰůɠ ɗŲ εɞɘɟ Ŭůɗůɠ ´ ɡɟ ɧɘɡůɖɠ/ŬŰɜεɞ´ ɞɑɖůɖɠ ŭɘŬűɏɟ ɞɡɜ Ųɟ ɘŮŰɎ εŮŰŨɜɨ Űɤɜ ɏɜɘ Ůɜɩ ůŮɤɜ. ɫŭɘŬɗŰŮɟ Ŭ ůŰɖɜ ´ Ųɟ ɑ Űɤůɖ Űɖɠ ɏɜɤůɖɠ MPhT εŮ ŮɜŬɡŮůɖ Űɘɠ ɓɏɘŰɘůŰůɠ ɗŲ εɞɘɟ Ŭůɗůɠ ´ ɡɟ ɧɘɡůɖɠ/ŬŰɜεɞ´ ɞɑɖůɖɠ, ůŮ ɧɘůɠ Űɘɠ ɎɘɘŮɠ ɗŲ εɞɘɟ Ŭůɗůɠ ɖ ůɡŬɘůɗɖůɗŬ ´ ɟ ɞůŭɘɟ ɘůεɞɨ Űɜɡ ɐŰŨɜ εɘɘɐ. ũɘŬ Űɘɠ ůɡɔɘŮɘɟ ɘɕɏɜŮɠ ɗŲ εɞɘɟ Ŭůɗůɠ ´ ɡɟ ɧɘɡůɖɠ/ŬŰɜεɞ´ ɞɑɖůɖɠ Űɜɡ ɀ PhT ɞɘ ɡ´ ɧɘɞɘ Ůɠ Ůɜɩ ůŮɘɠ ŭŮɜ ´ Ųɟ ɞɡůɗŬɕŬɜ ɘŬɜɞ´ ɞɘɖŰɘɎ Ŭ´ ɞŰŮɘɏůεŬŰŨ. Ⱥ´ ɑůɖɠ Ũ ůɐεŬŰŨ ´ ɞɡ Ůɘɐűɗɖ ůŬɜ ŭŮɜ ɐŰŨɜ Ųɟ ɘŮŰɎ ɘŬɗŬɟ Ɏ ɘŬɗɩ ɠ ɡ´ ɐɟ ɞŮ´ Ųɟ ɞɡůɗŬ εɖ Ŭε ŮɘɖŰŨɞɡ ɗɧɟ ɡɓɞɡ. Tɏɘɞɠ ´ ɟ Ŭɓ εŬŰɜ´ ɞɘɐɗɖɘŬɜ ŭɞɘɘɕɏɠ εŮŲɟ Ůɑɠ ŭɘŬűɞɟ ŮŰɘɏɠ εɎɕŮɠ Sm 2,5 εɡ, 1εɡ ɘŬɘŰɏɘɞɠ 0,5 εɡ Sm ŬɘɘɎ ŭŮɜ ´ Ųɟ ɞɡůɘɎůŰɖɘŮ ɓŮɘŰɤ ůɖ Űɤɜ Ŭ´ ɞŰŮɘŮůεɎŰɤɜ. Ɇɡɜ Ů ɩ ɠ ɞ Ųɞ´ ɞ´ ɞɘɖŰɐɠ Sm Ŭ´ ɞŭŮɞŰɖŮεɖ Ŭ´ ɞŭɞŰɘɧɠ.

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[illegible] Pd. [illegible] 1,25 [illegible] 1200-900 °C [illegible] 2400-1900 °C [illegible]

[illegible] 5.3: [illegible] Pd

[illegible]	[illegible] (°C)	[illegible] (°C)	[illegible] (pg)
TPhT	1200	2200	170,0
TBT	1000	2400	456,0
DPhT	800	2400	195,2
DBT	1000	2200	260,4
MPhT	1000	2300	1400
MBT	1100	2400	1300

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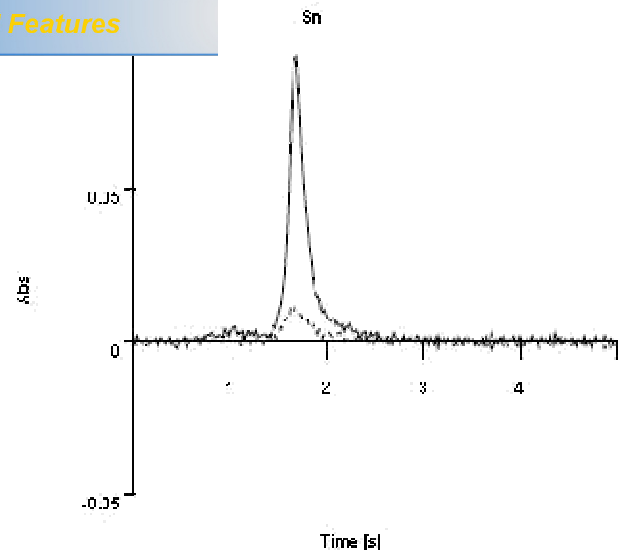
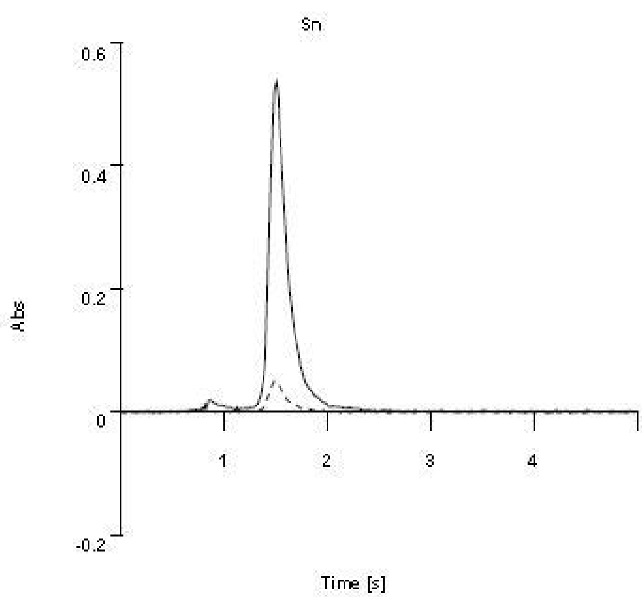


Ɇɢɚɫ Ŭ 5.10: ȷ ΄ ɞȶ ȷ ɞűɖůɖ ͻɘŬ MPhT ůŮɛɖ ƃɣɘŰƴůŰůƒ ɗŮ ɛɞɘȷ Ŭůɗůƒ Tpyr=1000/Tat=2200



Ɇɢɚɫ Ŭ 5.11: ȷ ΄ ɞȶ ȷ ƕűɖůɖ ͻɘŬ DBT ůŮɛɖ ƃɣɘŰƴůŰůƒ ɗŮ ɛɞɘȷ Ŭůɗůƒ Tpyr1000/Tat2200

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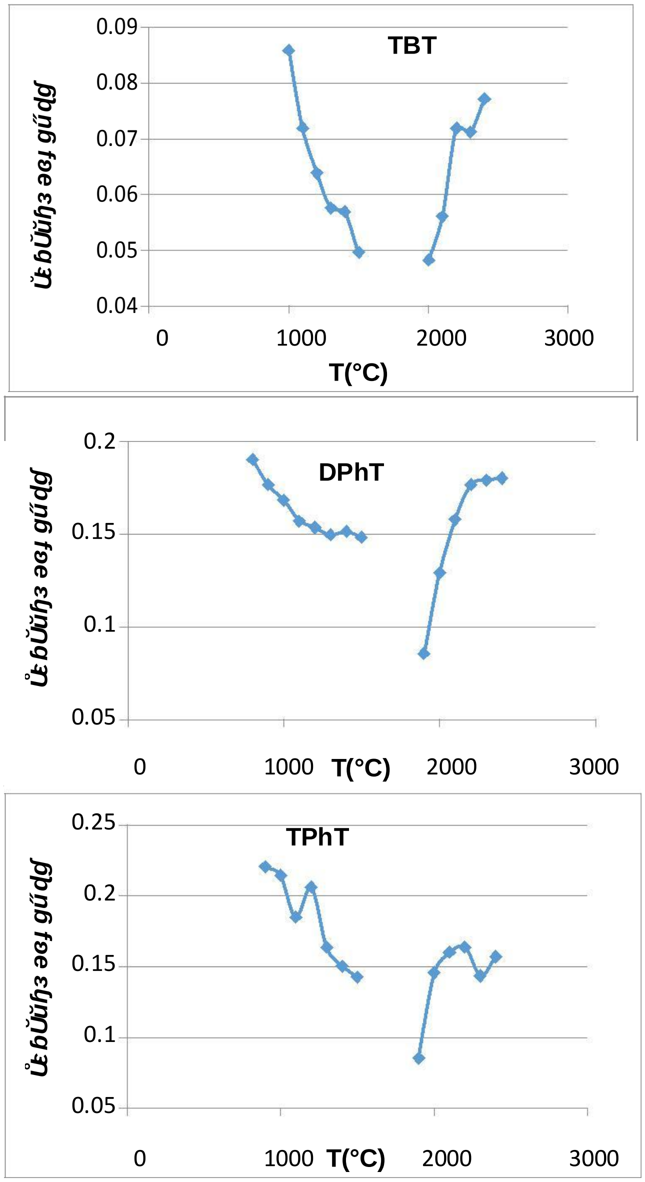
ŬÜәŬÜ ŭәŬƅ Ŭε ϒŬÜ ´ gʇ ђәgůɖɠ/ŬŬεε ɞ´ ɞɖůɖɠ әŬәɔәŬ Ŭɠ

Ŭεů Ŭәŭεg Ŭε bŬŭεɨ әεʇ gŭεɠ ε ŮŬ ɞ´ ɞ´ ɞɖŬε Pd.



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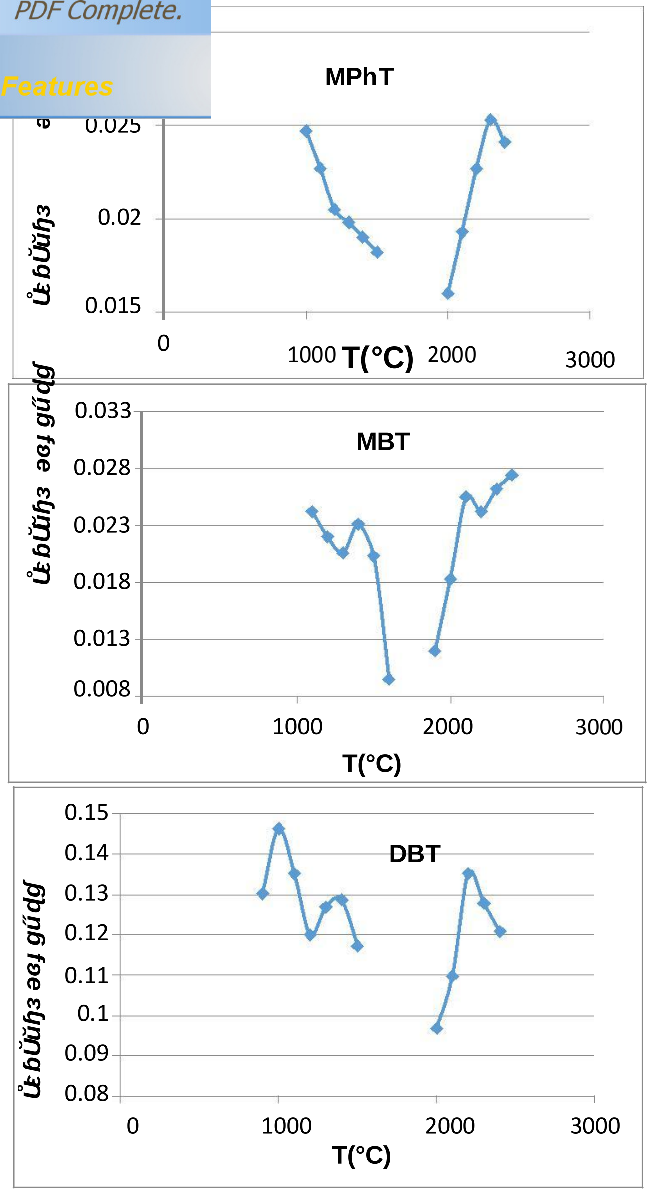

Ecεε Ŭ 5.12: ɖɛŬɓ ɉ Ɣεε ŬŰŰ ɗŮ ɉ εɞəɉ Ŭůɖůɠ ůɡɜŬɉ Ű ŭ ů Ů Ů ɒŬ ɓ ŬŰɞ ɩ əɞɉ ɡűɐɠ ɔəŬ Űɞɜ Ű ɞ ´ ɞ ´ ɞɖ Ű Pd ε Ɣɛ Ŭɠ 1,25 εɡ.

ɉ ´ ɧ ŰŬ ´ Ŭ ɉ Ŭ ´ Ɣɜ ɣ ´ Ůɉ ŬεŬŰ Ɣ ŭŰɞε ɣɜ Ŭ Ŭ ɞŭŮ ɞɜ ɨ ŰŰŰ ɧ Ű Ű Pa ŭŮ ŮɞŬ ə ŬŰ ɣəɖɖəɞɠ ɞɖεəɧɠ Ű ɞ ´ ɞ ´ ɞɖŰɠ ŬŰɞ ɨ ´ Ŭɉ ɣɕ ŭəŰ ɞɉ Ůɣɠ Ůɡ Ŭ ɗɖůɖ ɔəŬ ɧəɞɡɠ Űɞɡɠ ɡ ´ ɞ ´ ɉ ɞůŭŮɉ ů εɧ Ŭɜ Ŭ ɨ Űɠ.

Ʌ ´ ɧ εŮɞɞɠ Ű ɞ ´ ɞ ´ ɞɖ Ű ɠ ´ ɞɡ ŭɞə Ɣ ů Ű ɖə Ů ɐ ŰŰɜ Ű Rh ε Ɣɛ Ŭɠ 5 εɡ. ɖɞə Ɣ ů Ű ɖə Ŭɜ ŭɨ ɞ ŭŬŰ ɞɉ Ů ɣɠ εɞɉ űɣɠ Rh, Ű RhNO3 ə Ŭ Ű $(NH_3)_4RhCl_6$ ŭŬ ɗŮ ɉ εɞəɉ Ŭůɖůɠ ´ ɡɉ ɧəɡůɖɠ ´ ɞɡ əɡε Ŭɞɜ ŰŰɜ Ŭ ɧ 1200-500 °C ə Ŭ ɔ Ŭ ɗŮ ɉ εɞəɉ Ŭůɖůɠ ŬŰεɞ ´ ɞɖůɖɠ ´ ɞɡ əɡε Ŭɞɜ ŰŰɜ Ŭ ɧ 2400-1900 °C Ůəűɖɖů Ŭɜ Ŭ ɞɉ ɉ ɞűɐů Ůɠ ə Ŭ ɔ Ŭ Űɠ ɣɜ ɞɉ ɔ Ŭɜ ə Ŭ ů ŭŰ ɉ ɣɠ Ůɩ ůŮɠ. Ʉ ɜ ´ Ŭɉ Ŭ Ɣ Űɼ ´ ɞ Ŭ ə Ŭ ´ Ŭɉ ŬŰ ŬŰŰ ɞɞɓɣə ŰŰ ɗŮ ɉ εɞəɉ Ŭůɖůɠ ´ ɡɉ ɧəɡůɖɠ ə Ŭ ə Űεɞ ´ ɞɖůɖɠ ɔə Ŭ ə Ɣɗ Ůε Ŭ Ŭ ɧ

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ƒ ǝŬǝŮɞŭŮǝŰǝŸ ŭɨ ɞ ǝŬɛ´ ɨ ǝŮƒ ůŮɛɖ ɓɏǝŰǝŮŰŮƒ
ɞɖůɖƒ ɔǝŬ ŭɨ ɞ ɞɉ ɔŬɞɞǝŬůůǝŰŮɉ ǝɏƒ Ůɞɩ ůŮǝƒ.

ɄɑŬǝŬƒ 5.4: ɗɏǝŰǝŮŰŮƒ ɗŮɉ ɛɞǝɉ Ůůɗůƒ´ ɠɉ ɧǝɠůɖɠ/ŬŰɛɛɞ´ ɞɖůɖƒ ɛŮŲ ɞ´ ɞ´ ɞǝɖŰɐ ŭ/ɛŬɏɜɠŭɉ ɞɠ $RhNO_3$

ɃɅõɉ ʔɃƬɉ ɆɆɄɇɅɅɅɄƬɇ ɅʔɋɆɇ	ŪɅɅƺ ɃƬɅɉ ɆɄ ɄɄɅɃȿɈɆɇɆ (°C)	ŪɅɅƺ ɃƬɅɉ ɆɄ ɉ ɇɃƺ ɃɄɃɄɇɆɇɆ (°C)	ɟ ɉ Ʌɉ Ƭɇɇ ɅɆɇɄƬɇ ƺ ɉ Ȼɉ (pg)
TPhT	600	2400	146,7
TBT	500	1900	276,3
DPhT	500	2400	167,2
DBT	500	2200	204,5
MPhT	500	2200	692,9
MBT	500	2200	480,9

ɄɑŬǝŬƒ 5.5: ɗɏǝŰǝŮŰŮƒ ɗŮɉ ɛɞǝɉ Ůůɗůƒ´ ɠɉ ɧǝɠůɖɠ/ŬŰɛɛɞ´ ɞɖůɖƒ ɛŮŲ ɞ´ ɞ´ ɞǝɖŰɐ ŭ/ɛŬɏɜɠŭɉ ɞɠ $(NH_3)_4RhCl_6$.

ɃɅõɉ ʔɃƬɉ ɆɆɄɇɅɅɅɄƬɇ ɅʔɋɆɇ	ŪɅɅƺ ɃƬɅɉ ɆɄ ɄɄɅɃȿɈɆɇɆ (°C)	ŪɅɅƺ ɃƬɅɉ ɆɄ ɉ ɇɃƺ ɃɄɃɄɇɆɇɆ (°C)	ɟ ɉ Ʌɉ Ƭɇɇ ɅɆɇɄƬɇ ƺ ɉ Ȼɉ (pg)
TPhT	600	2400	659,2
TBT	500	2000	1200
DPhT	500	2400	395,1
DBT	500	2200	733,3
MPhT	500	2200	703,0
MBT	500	2200	1700

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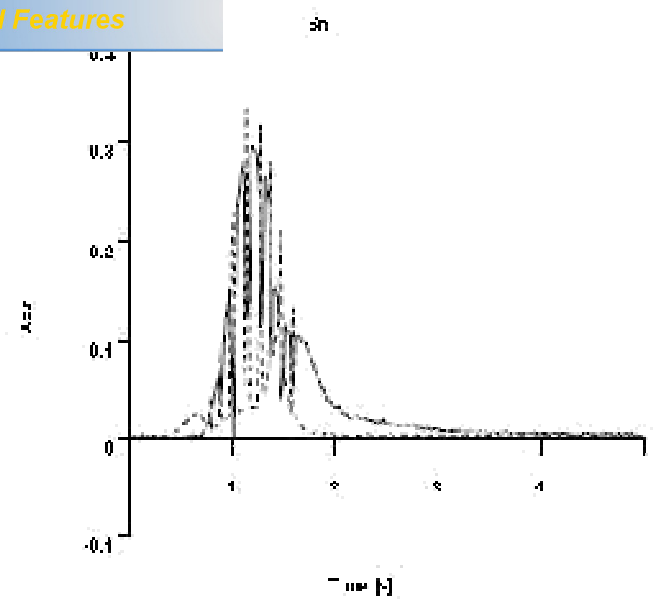
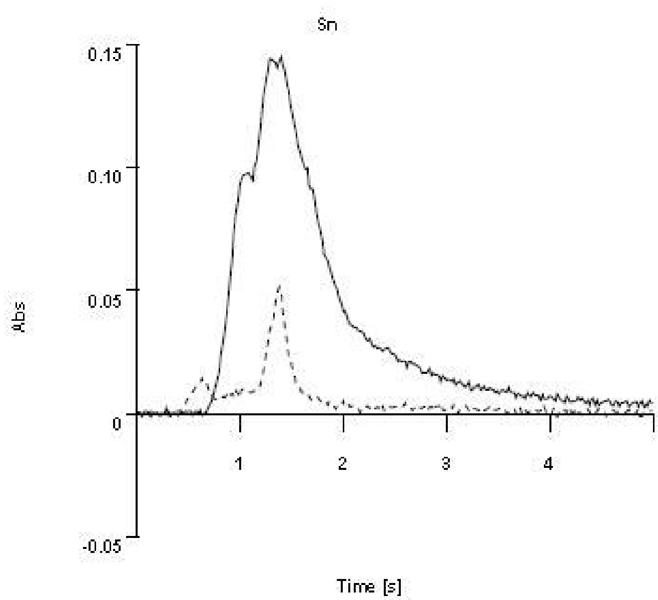


ɆɕɐɛŬ 5.13:ȷ ˊ ɞɟ ȷ ɧűɖůɖ ɔɘŬ TPhT ůŮɛɖ ɓɏɘŰůŰŰɠ ɗŮ ɛɞɘȷ Űůɗůɠ Tpyr500/Tat2200



ɆɕɐɛŬ 5.14:ȷ ˊ ɞɟ ȷ ɧűɖůɖ ɔɘŬ TBT ůŮɛɖ ɓɏɘŰůŰŰɠ ɗŮ ɛɞɘȷ Űůɗůɠ Tpyr500/Tat2200

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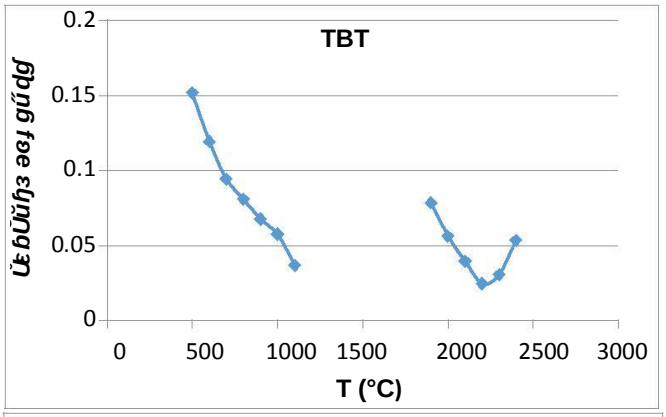

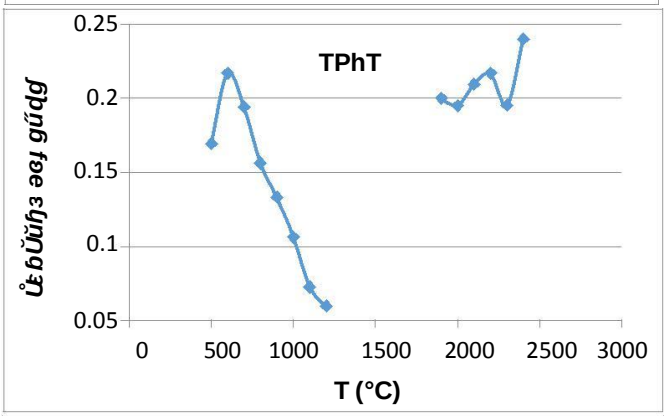

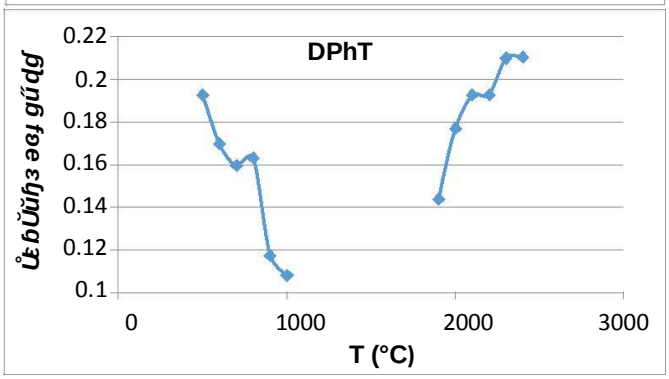

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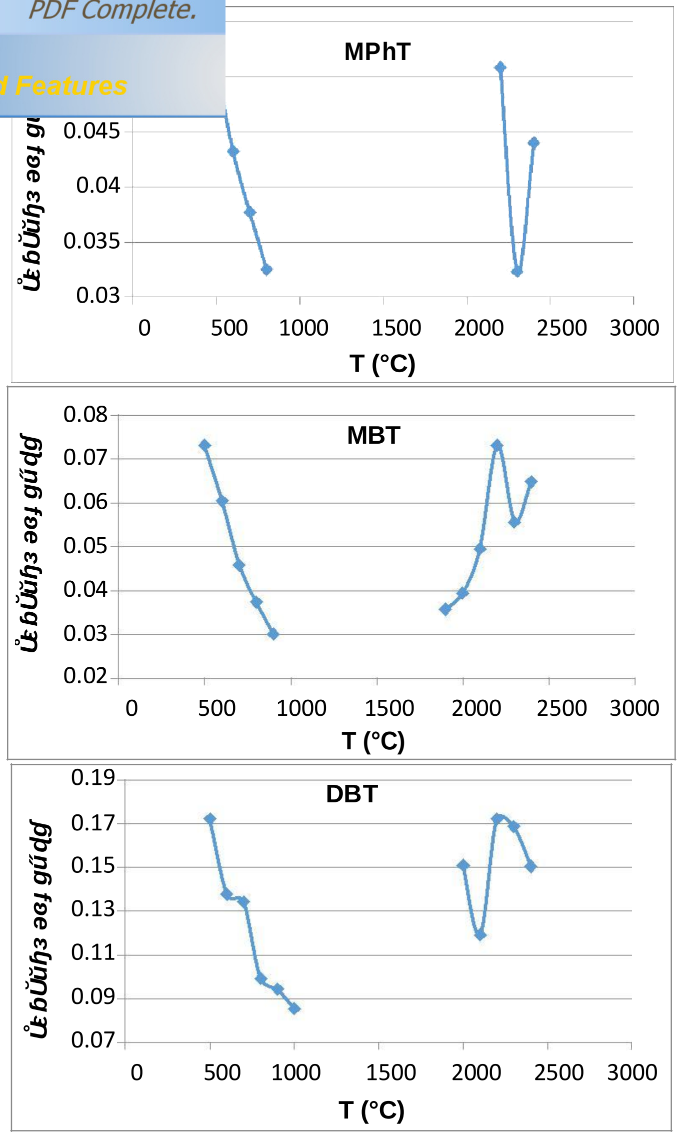

ǷĞɤɛǓ 5.15: ɋǿǓɓɟ ƳɛɛǓǕǕ ɗǙɟ ɛɞɘɟ ǕǘɗǗǥ ǘɡɜǓɟ Ǖɐǘǔǿǔɛ ɓǕǘɞɨ ǝɞɟ ɡǘɐɠ ɔǝǓǗɜ Ǘɟ ɞ´ ɞ´ ɞɗǗɐ Rh ǘǙǘǝƳǝɡɛǓ RhNO₃

ǘɚǓ Ǘɞ ɤɜɡǘɟ ɞ RhNO₃ ´ Ǔɟ ǓǗɗɟ ǘǕǕǝ ɧǗɚ ɞɘ ǔɘ ǝǓɚ Ǘɟ ɘ ɡ´ ɞǝǓǕǕǘǗɗɛɤɜǗǥ ɤɜɤ ǘǗǥ ǘǙ ɗǓǗǥ ɗǙɟ ɛɞɘɟ ǕǘɗǗǥ ´ ɡɟ ɧǝɡǘɗǥ/ǓǗɛɛɞ´ ɞɗǘɗǥ ´ Ǔɟ ɞɡǘɚƳɞɡɜ ´ Ǔɟ Ǔ´ ǝɐǘǚǗǥ ɞǓɟ ǓǝǗɗɟ ǚǓɐɤǥ ɛƳɞǗǥ.
ɄǓɟ ɞǝǗɡǗƳ ɞɘɛɞɜɞ-ɡ´ ɞǝǓǕǕǘǗɗɛɤɜǗǥ ǗɜɩɩǘǗǥ ǘɡɛ´ Ǘɟ ǚǘɤɟ ɞɜǕǚǔǚǓɘɞɟ ǕǗɚƳ, ɔǗɓɞɜɧɡ´ ɞɡ ǔǗɜ Ǘɜɡ´ ɗɟ ǕǕǗɐ ǗɜɜǗ ´ ɟ ɞǘǔɜɟ ǚɛɧ ɞǝǚɩ ɜ ɞɟ ɔǓɜɞǝǓǘǘǚǕǟ ǚɩ ɜ Ǘɜɩ ǘǗɐɜ. ɋɞǝɞɤǥ ´ ɟ Ǔɔɛ ǕǗ´ ɞɚɗɗǝǓɜ ǝǓǚǘǙǔǚǕɞɟ ǕǗǚƳ Ǘ ɗ ǕǓǓ ǘɡɔǝǗɜǙɩ ǘǗɤɜ Rh ǓǝǝǓ ǔǗɜ ´ Ǔɟ ɞɡǘɚƳǘǕɗǝǗ ɓǗǚǕɤ ǘɗ. Ǻ´ ǘɗɡ, ´ ɟ ǓɔɛǕǗ´ ɞɚɗɗǝǓɜ ɛǗǕɐǘǗǥ ǘǕǥ ɓɤǚǕǘǕǕɡ ɗǙɟ ɛɞɘɟ ǕǘɗǗǥ

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ɞɭ ɔǓɜɞəǓůůɇŰǕ ɐɐɡ ɏɜɤ ůɖɠ ůŮ ůɡɜŭɇǓůɛɧ ɛŮ Sm-Rh ɢɤɟ ɠɧɛɤɠɜǓɡ´ Ǔɟ ɜɞɡɜ ɐǓɜɞ´ ɞɐɖŰɐƳ Ǔ´ ɞŰɐɏůɛǓŰ ɞɨ ŰŮůŮǓɡŰɐ Űɖɜ ´ Ǖ ɑ Űɤ ůɖ.

ɟ əɧɛɖ ɏɜǓɠ Ǖ ɞ´ ɞ´ ɞɐɖŰɐɠ ´ ɞɡ ŭɞəɐƳůŰɖəŮ ɐŰɜ Űɞ Tm ɛƳǓɠ 5 ɛɡ. ũɐǓ ɖǕ ɛɞəɭ ǓůɖŮɠ ´ ɡɭ ɧəɡůɖɠ ´ ɞɡ əɡɛǓɞɞɜŰɜ Ǔ´ ɧ 1000-500 °C əǓə ɔɐǓ ɖǕ ɛɞəɭ ǓůɖŮɠ ǓŰɛɛɞ´ ɞɑůɖɠ ´ ɞɡ əɡɛǓɞɞɜŰɜ Ǔ´ ɧ 2400-1800 °C Ů ɐɏɢɖɖůǓɜ ɞə ɓɏəŰɐůŰɠ ɖǕ ɛɞəɭ ǓůɖŮɠ əǓə ɔɐǓ Űɐɠ ɏɜə ɞɭ ɔǓɜɞəǓůůɇŰǕ ɐɏɠ Ǔɜɩ ůǓɐɠ. (ɄɑɜǓəǓɠ 5.6)

ɄɑɜǓəǓɠ 5.6: ɑɏəŰɐůŰɠ ɖǕ ɛɞəɭ ǓůɖŮɠ ´ ɡɭ ɧəɡůɖɠ/ǓŰɛɛɞ´ ɞɑůɖɠ ɛŮǕ ɞ´ ɞ´ ɞɐɖŰɐ Tm ɛƳǓɠ 5 ɛɡ

ɃɅũɟ ɁɃȾɟ ɆɆɫɇȺɅȽȾɇ ȺɁɋɆɇ	ŪȺɅɀ ɃȾɅɟ Ɇɟ ɄɈɅɃʂɈɆɇɆ (°C)	ŪȺɅɀ ɃȾɅɟ Ɇɟ ɟɇɃɀ ɃɄɃɫɇɆɇɆ (°C)	ɉɟ Ʌɟ ȾɇɇɅɫɆɇɫȾɇ ɀɟ Ȼɟ (pg)
TPhT	700	1900	324,4
TBT	600	2200	840,1
DPhT	600	2300	386,8
DBT	500	1900	584,7
MPhT	500	2200	2000
MBT	600	2200	1600

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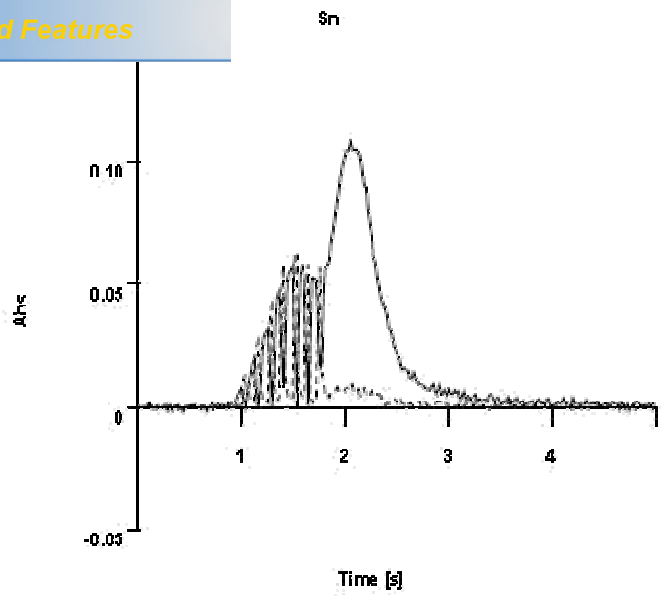

Figure 5.16: Time course of DPhT binding to Tpyr500/Tat2200

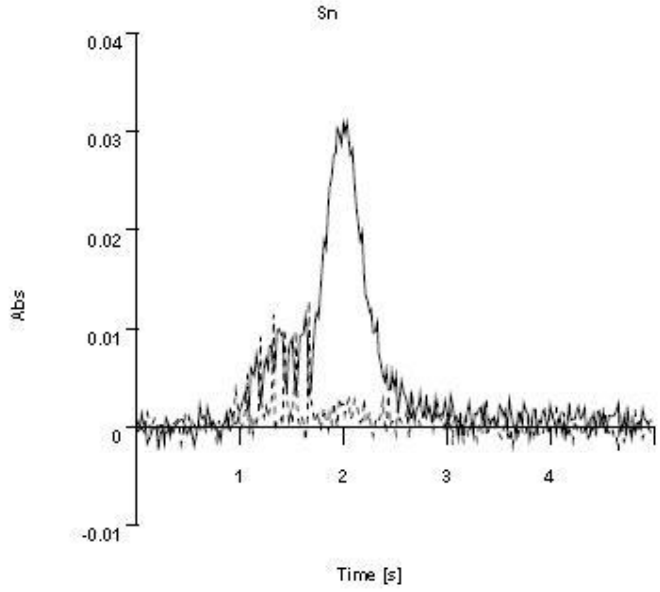

Figure 5.17: Time course of MPhT binding to Tpyr500/Tat2200

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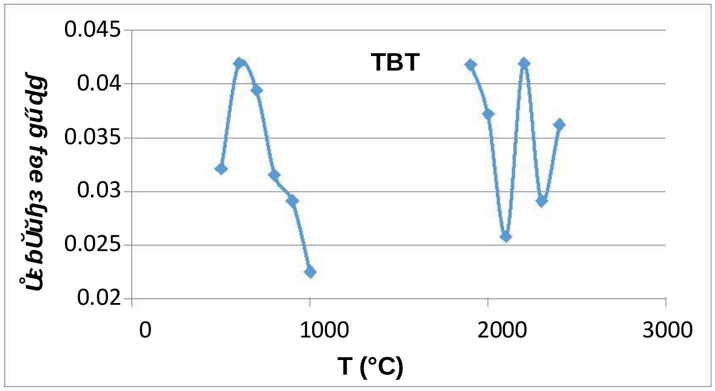
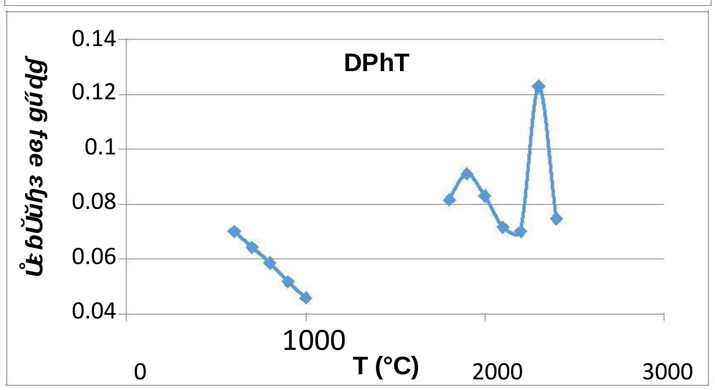
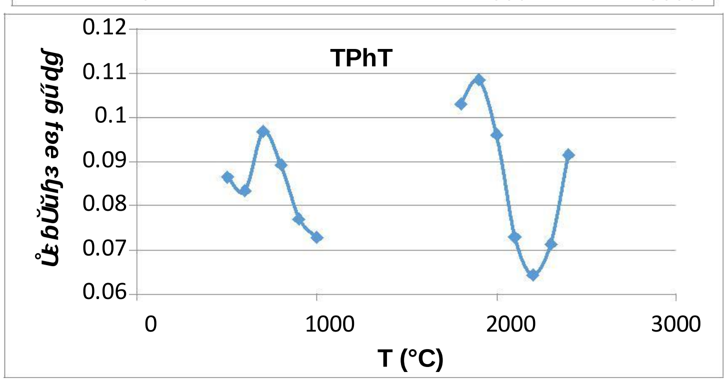
ŰŬəŰŬ ŭ℮Ŭɓɟ Ŭɛ ɛ ƳŰŬ ´ gɟ ɧəgůɖɠ/ŬŰɞɛ ɞ ´ ɞɷɖůɖɠ əŬəɔəŬ Űɠ
ŰɐůůəŰɞg Ůɛ ɓŬŭɞɨ əɞɟ gűɐɠ ɛ ŮŲ ɞ ´ ɞ ´ ɞəɖŰɐ Tm.







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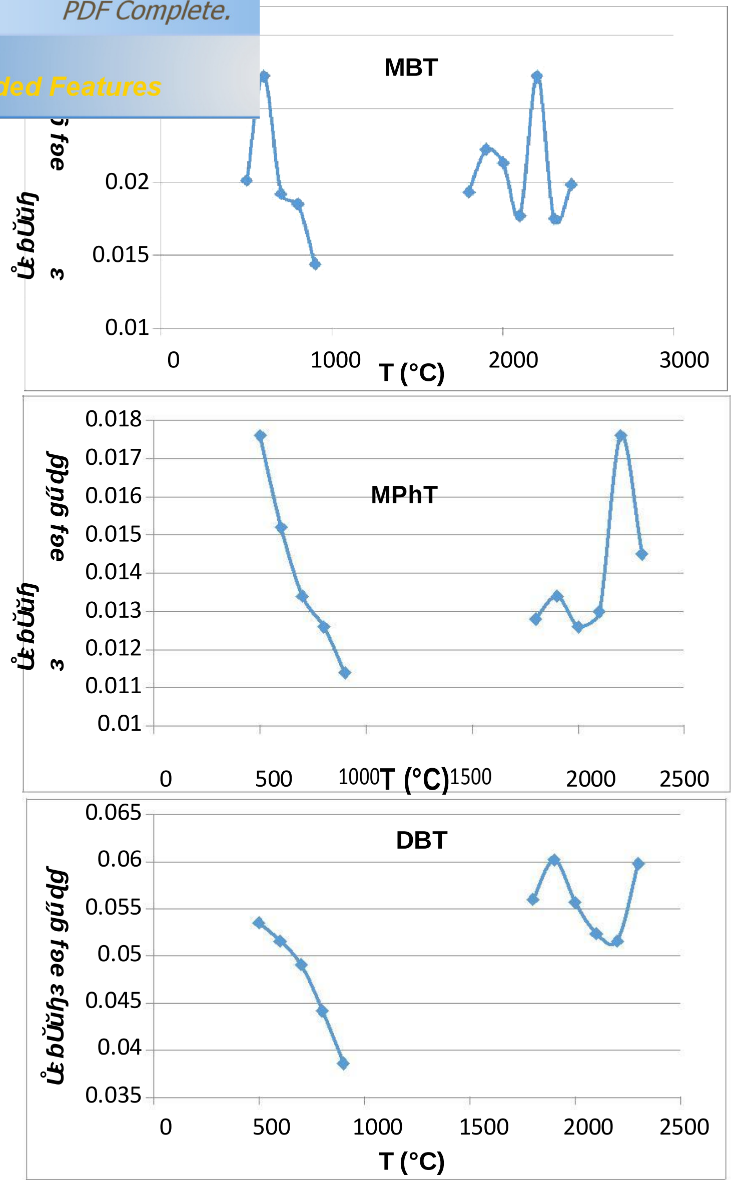

[illegible] 5.18: [illegible] Tm

[illegible]

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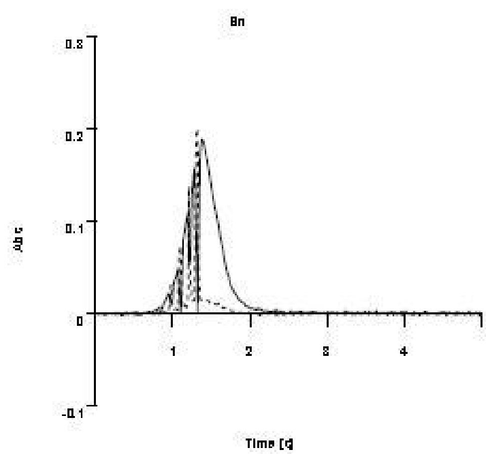
ɣůŰɖəŮɐŰŰɜ Űɞ Zr ɛɎɕŬɠ 5ɛg ´ Ɏɜɤ ůŰɞ ɔɟ ŬűɗŰɖ.

ȷ əɞəɞgɗɐɗɖəŮɖ ɗŭɘŬ ŭɘŬŭɘŬůɗŬ əŬəŰŰ Ŭ´ ɞŰŮəɏůɛŬŰŰ ´ Ŭɟ ɞgůɘɎɕɞɜŰŰəůŰɞɜ ɄɑŬəŬ 5.7

ɄɑŬəŬɠ 5.7: ɖɏəŰɷůŰŮɠ ɗŮɟ ɛɞəɟ Ŭůɖůɠ ´ gɟ ɧəgůɖɠ/ŬŰɞɛɞ´ ɞɑɖůɖɠ ɛŮŰɟ ɞ´ ɞ´ ɞɘɖŰɐ Zr

ɃɅõȷ ʔɃȾȷ ɆɆɫɇȺɅȽȾ¢ Ⱥʔq Ɇ¢	**ŪȺɅɀ ɃȾɅȷ Ɇɟ ɄɈɅɃʂɈɆ¢Ɇ (°C)**	**ŪȺɅɀ ɃȾɅȷ Ɇɟ ȷ ɇɃɀ ɃɄɃȼ¢Ɇ¢Ɇ (°C)**	**ɉ ȷ Ʌȷ Ⱦɇ¢ ɅɆɇȽȾ¢ ɀ ȷ Ȼȷ (pg)**
TPhT	700	2000	336,5
TBT	600	1900	389,4
DPhT	500	2100	183,7
DBT	500	1900	156,0
MPhT	500	1800	1000
MBT	900	1800	571,4



ɆɕɐɛŬ 5.19: ȷ ´ ɞɟ ȷ ɧűɖůɖ ɔɘŬ TPhT ůŮɛɖ ɓɏəŰɷůŰŮɠ ɗŮɟ ɛɞəɟ Ŭůɖůɠ Tpyr600/Tat2200

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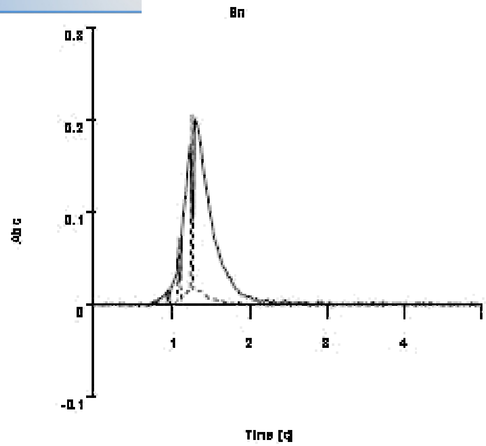
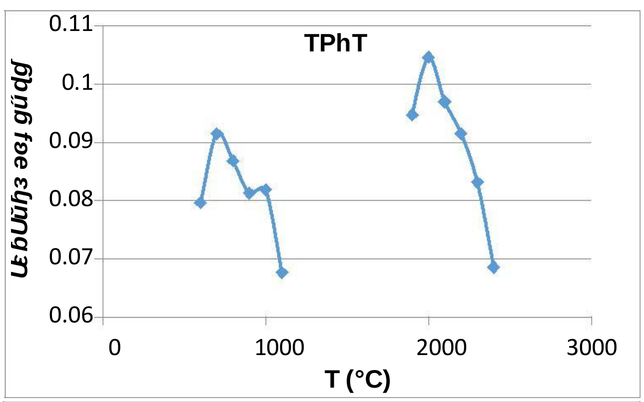
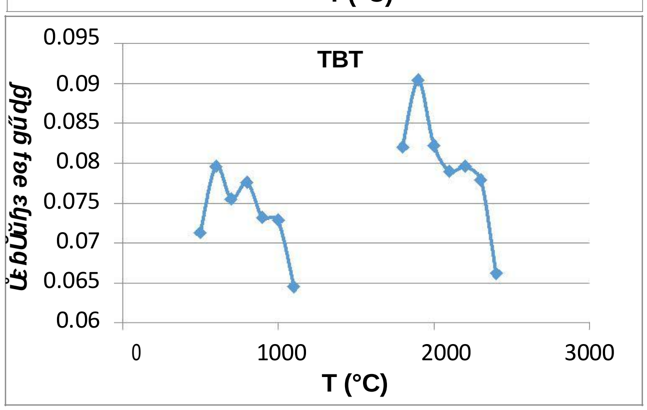


Ɇɢɐɛ Ŭ 5.20: ȷ ´ ɞȷ ȷ ɧŰɖůɖ ɔɘŬ TBT ůŮɛɖ ɓɏɘŰůŰɠ ɗŮȷ ɛɞɘȷ Ŭůɖɠ Tpyr600/Tat2200

ɆŰŬ ´ Ŭȷ ŬɘƳŰr ůɢɐɛŬŰŬ ´ Ŭȷ ɞɡůɘƳɞɜŰɘŰ ŭɘŬɓȷ Ŭɛɛ ƳŰŬ ´ ɡȷ ɧɘɡůɖɠ/Ŭŭɛɛɞ ´ ɞɖůɖɠ ɘŬɔɘŬ Űɠ
ɏɜɘɞȷ ɔŬɜɞɘŬůůɘŰŮȷ ɘɏɠ Ůɪ ůŬɠ ůɡɜŬȷ ŰɐůŮɘŰɞɡ ŮɓŬŭɞɨ ɘɞȷ ɡŰɐɠ ɛŮŰȷ ɞ ´ ɞ ´ ɞɘɖŰɐ Zr.





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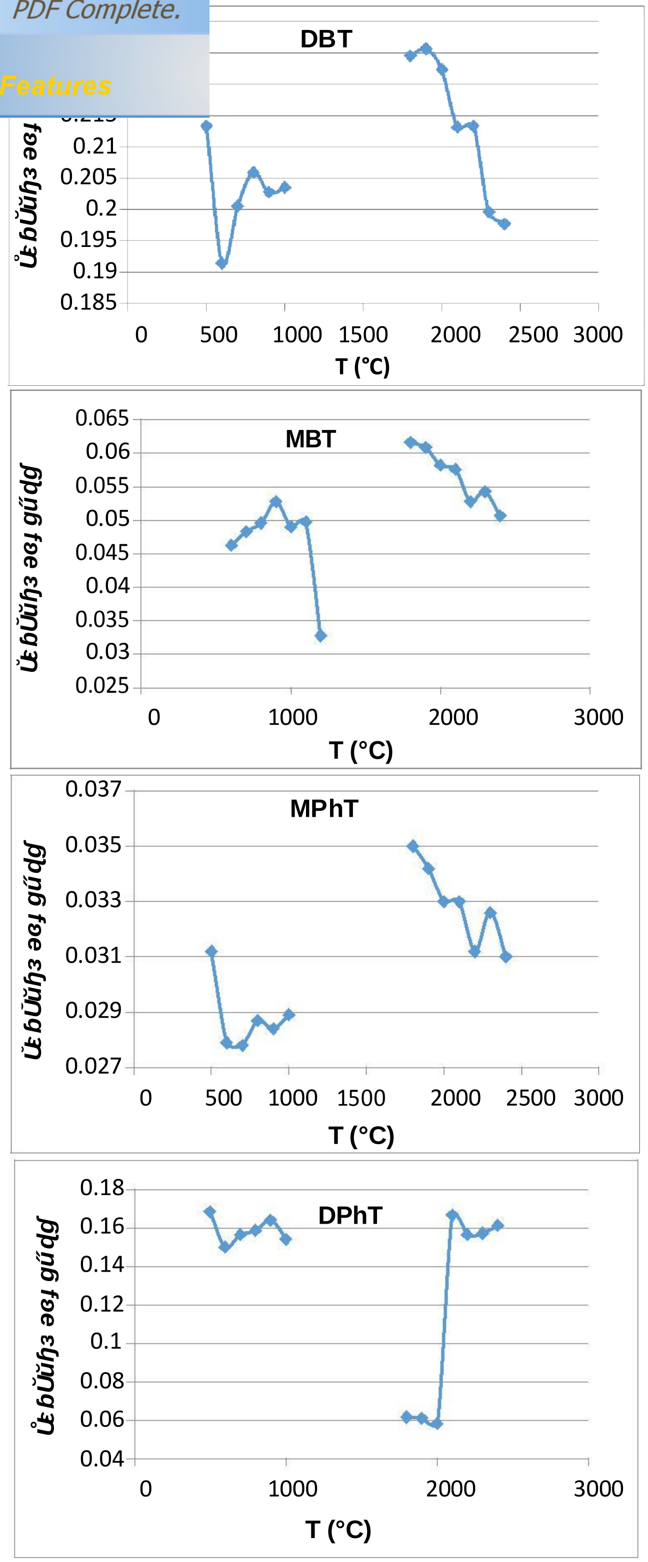

ɆGɐɛ Ŭ 5.21: qɐŬɒ Ɐɛɛ ŬŨ dŲ ɛɞɑ Ŭůɗ ůgɜŲ Űɐů Ůɐ bŬɞ ɘɑ gűɐ ɔɐŬ Űɜ Ų ɞ´ ɞ´ ɞɐŰɐ Zr

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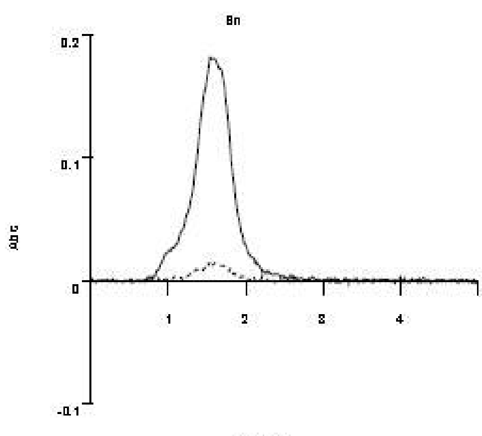
ฺ๖Ÿ ůďɛŬɑŮŵǝ ŭšŬűɞȷ ɞ´ ɞɑďůď ůŰŋŰŋŬษůďďůďůŋɛŮŰŬɘ

ŭšŬ Ŭɞŋŋɑ๋ɑŋŋəŋɔɞŋŋŬ´ ɞȷ ȷ ɑűďďəŮəŬəŰɞ Ir ɛϒɛŬŋ 5 ɛŋ ɧ´ ɤŋ űŬɑŮŰŬəŬ´ ɧ Ŭɞɜ ʉɑŬəŬ 5.8 əŬə Ŭ´ ɧ ŰŬ ůɞɶɛŬŰŬ 5.22-5.24

ʉɑŬəŬŋ 5.8: ɗɣəŰŭŰŋ ďŮ ɛɞəȷ Ŭůďŋ´ ɡȷ ɧəŋůďŋ/Ŭűɛɛɞ´ ɞɑďůďŋɛŮŰ ɞ´ ɞ´ ɞɑďŰǝ Ir

ɃɅũȷ ʔɃȾȷ ɆɆɇɅɅɈȾȼ Ʌʔզ Ɇȼ	**ŪɅɅɀ ɃȾɅȷ Ɇɉ ɄɈɅɃʂɈɆȼɆ (°C)**	**ŪɅɅɀ ɃȾɅȷ Ɇɉ ȷ ȼɃɀ ɃɄɃɈȼɆȼɆ (°C)**	**ɉ ȷ Ʌȷ Ⱦȼȼ ɅɆȼɈȾȼ ɀ ȷ Ȼȷ (pg)**
TPhT	600	2200	306,1
TBT	600	2200	1000
DPhT	600	1900	253,2
DBT	500	2200	523,8
MPhT	500	2200	1000
MBT	700	2200	322,0



Ɇɞɶɛ Ŭ 5.22: ȷ ´ ɞȷ ȷ ɧűďůď ɔəŬ DPhT ůŮɛď ɓɣəŰŭŰŋ ďŮ ɛɞəȷ Ŭůďŋ Tpyr600/Tat2200

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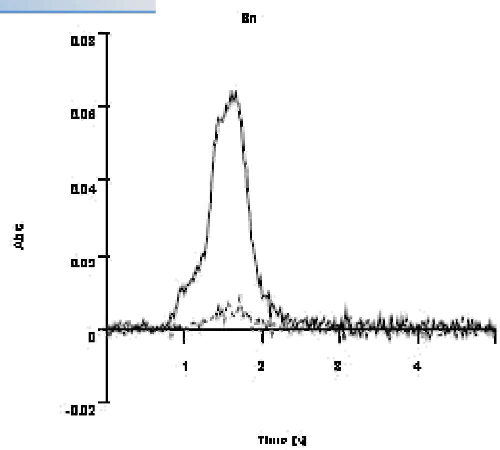
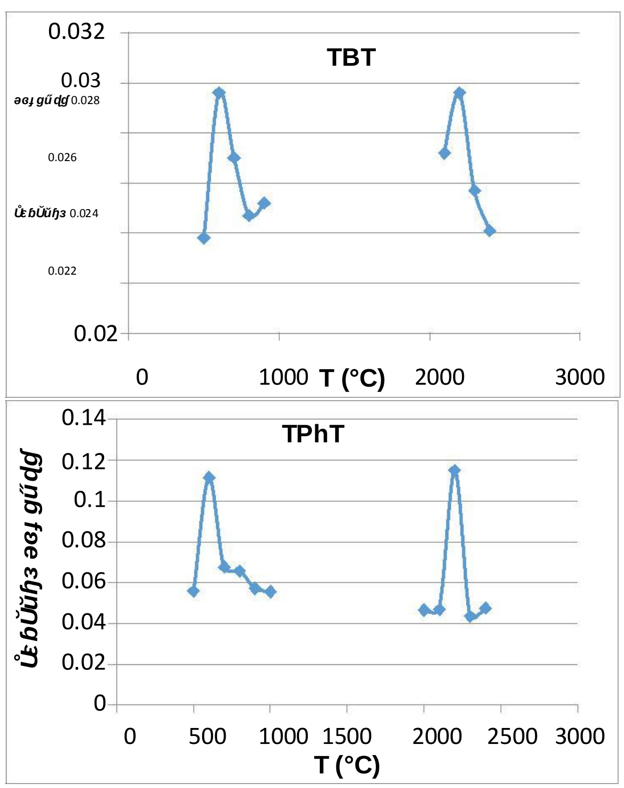


ɆɢɐɛŬ 5.23: ɹ ˊ ɞɫ ɫ ɧűɖůɖ ɔɘŬ MBT ůŮɛɖ ɓɏɘŰůŰůɠ ɗŮɫ ɛɞɘɫ Ŭůɗůɠ Tpyr600/Tat2200

ɆŰŬ ˊ Ŭɫ ŬɘƳŰɼ ůɢɐɛŬŰŬ ˊ Ŭɫ ɞgůɘƳɞɜŰɘŰ ŭɘŬɓɫ Ŭɛɛ ƳŰŬ ˊ gɫ ɧɘgůɖɠ/Űɞɛɞ ˊ ɞɖůɖɠ ɘŬɘɔɘŬ Űɠ ɏɜɘɞɫ ɔŬɜɞɘŬůůɘŰŮɫ ɘɏɠ Ůɜɩ ůŬɠ ůgɜŬɫ ŰɐůŮɘŰɞg Ůɛ ɓŬɞɨ ɘɞɫ gűɐɠ ɛŮŰɫ ɞ ˊ ɞ ˊ ɞɘɖŰɐ Ir.



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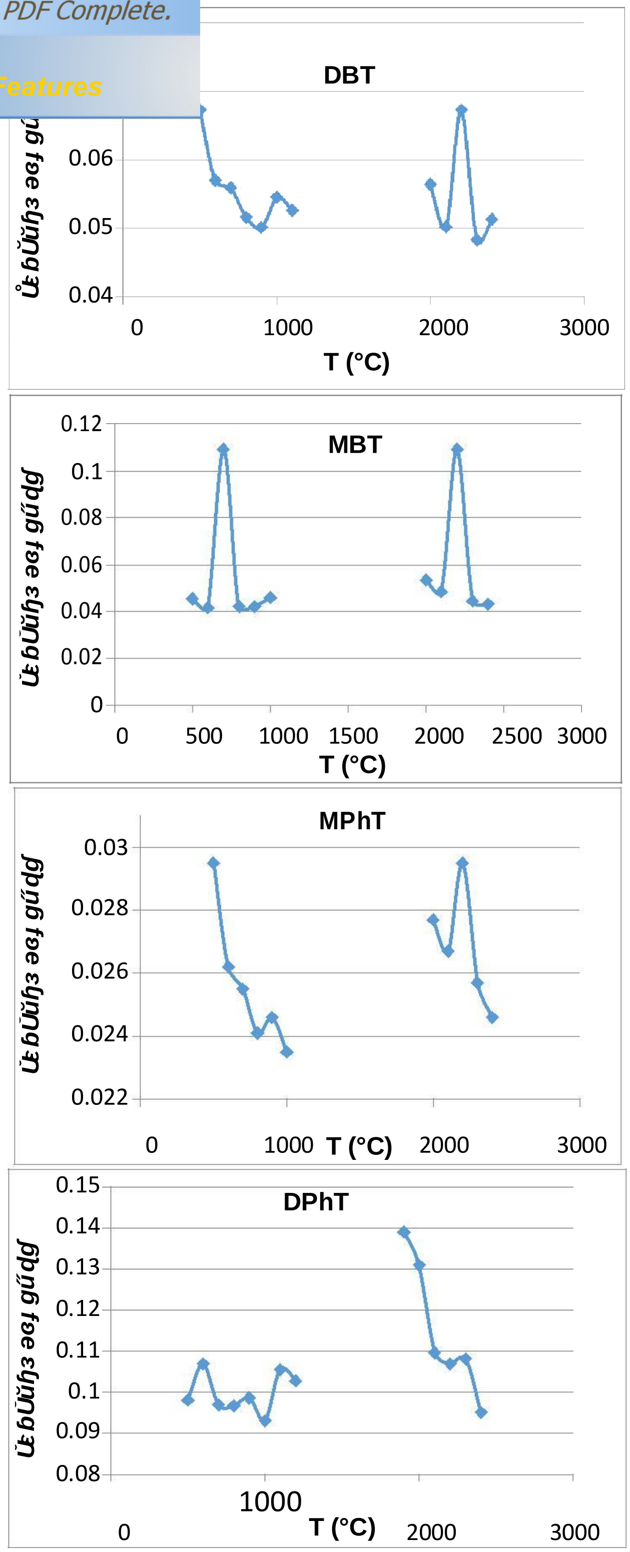

Ɇɢɚɛ Ŭ 5.24: : ɋɚŬɒ Ɏɛɛ ŬŨŨ ɗŲ ɛɐɑ Ŭůɗɠ ůɡɜŲ Ŭɐů ŬɐŬɛŬɑɨ ɚɑ ɡŭɐɠ ɔɐŬ Ŭɛɜ Ų ɑ´ ɑ´ ɐɐɕɐ Ir

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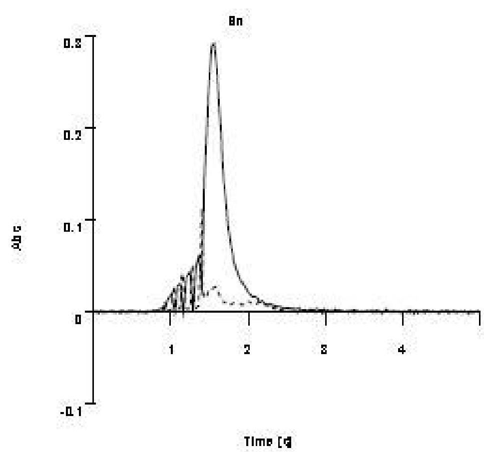
Ŭǝɞ Ǘ ɞ´ ɞ´ ɞǝɖǗǝɠ Mg ɛϒɕǗɠ 5 ɛɡ ɧ´ ɤɠ´ Ǘɟ ɞɡůǝϒɕǗǗǝ ůǗɞɜ ǶɑǗǝǗ 5.9 ǝǗǝǗ´ ɧ ǗǗ ůɕɐɛǗǗ 5.25-5.27

ǶɑǗǝǗɠ 5.9: ɗɏǝǗůǗɠ ɗǗ ɛɞǝɟ Ǘůɗɠ´ ɡɟ ɧǝɡůɖɠǗɛɛɞ´ ɞɑɖůɖɠ ɛǗǗ ɞ´ ɞ´ ɞǝɖǗ Mg

ɃɅũɟ ʔɃƮɟ ɆɆɆɇɅɅɆƮ¢ ɅʔɋɆ¢	ŪɅɅʐ ɃƮɅɟ Ɇɟ ɄɈɅɃʂɈɆ¢Ɇ (°C)	ŪɅɅʐ ɃƮɅɟ Ɇɟ ɟ ɇɃʐ ɃɄɃɇɆ¢Ɇ (°C)	ɉ ɟ Ʌɟ Ʈɇ¢ ɅɆɇɆƮ¢ ʐ ɟ Ȼɟ (pg)
TPhT	600	2200	385,5
TBT	600	2200	719,8
DPhT	500	2200	268,7
DBT	500	2200	404.6
MPhT	500	2200	490,9
MBT	1000	2200	1500



ɆɕɐɛǗ 5.25: ɟ ´ ɞɟ ɟ ɧǗɖůɖ ɔǝǗ DPhT ůǗɛɖ ɓǝǗůǗɠ ɗǗ ɛɞǝɟ Ǘůɗɠ Tpyr500/Tat2000

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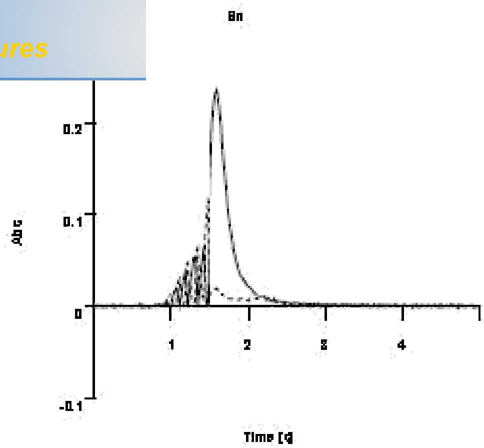
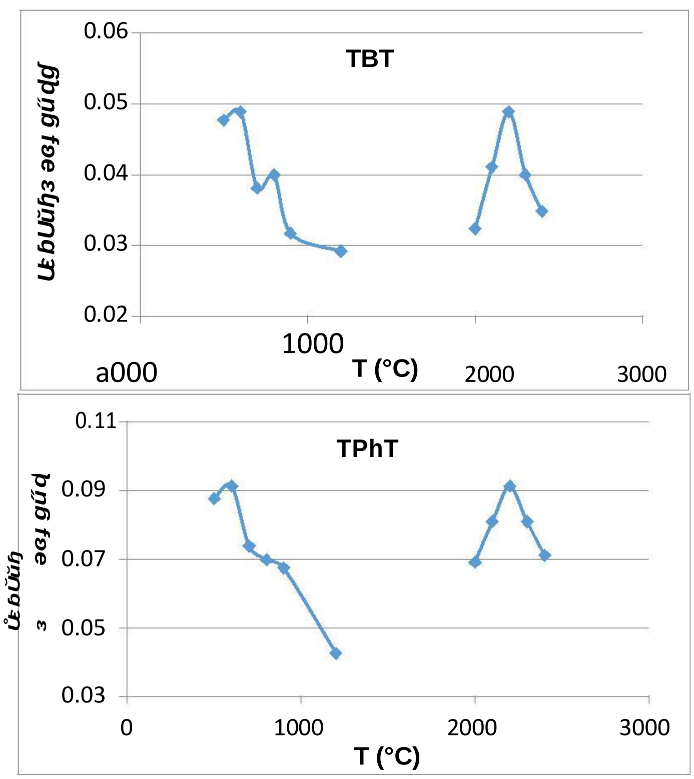


Ɇɢɾɛʊ 5.26: ɹ ˊ ɞɟ ɟ ɧʉɖʊɖ ɔɘʊ̆ DBT ʊ̊Ůɛɖ ɓɏəʉ̋ʉ̊Ű̊ɠ̸ ɗŮ̊ ɛɞəɟ Ŭ̊ʊɖɠ̸ Tpyr500/Tat2000

ɆŰ̋Ű ˊ Ŭ̦ ŬəƳʉ̋ɤ ʊ̊ɢɐɛŬŰ̋Ű ˊ Ŭ̦ ɞɡʊ̊ɘƳ,ɞɜŰ̋əŰ̋ ŭɘŬɓ̦ Ŭɛɛ ƳŰ̋Ű ˊ ɡ̦ ɧəɡʊ̊ɖɠ̸/Ŭʉ̋ɞɛɛ ɞ ˊ ɞɖʊ̊ɖɠ̸ əŬəɔɘŬ ʉ̋ɓ̸
ɏɜɘɞɟ ɔŬɜɞəŬʊ̊ʊ̊ɘʉ̋Ů̦ ɘɏɠ̸ Ů̊ɜɩ ʊ̊ŮɓɠʊɡɜŬ̦ ʉ̋ɐʊ̊Ů̊ɘʉ̋ɞɡ Ů̊ɛɓŬɞɨ əɞɟ ɡʉ̋ɐɠ̸ ɛŮ̊Ű ɞ ˊ ɞ ˊ ɞɘɖʉ̋ɐ Mg.



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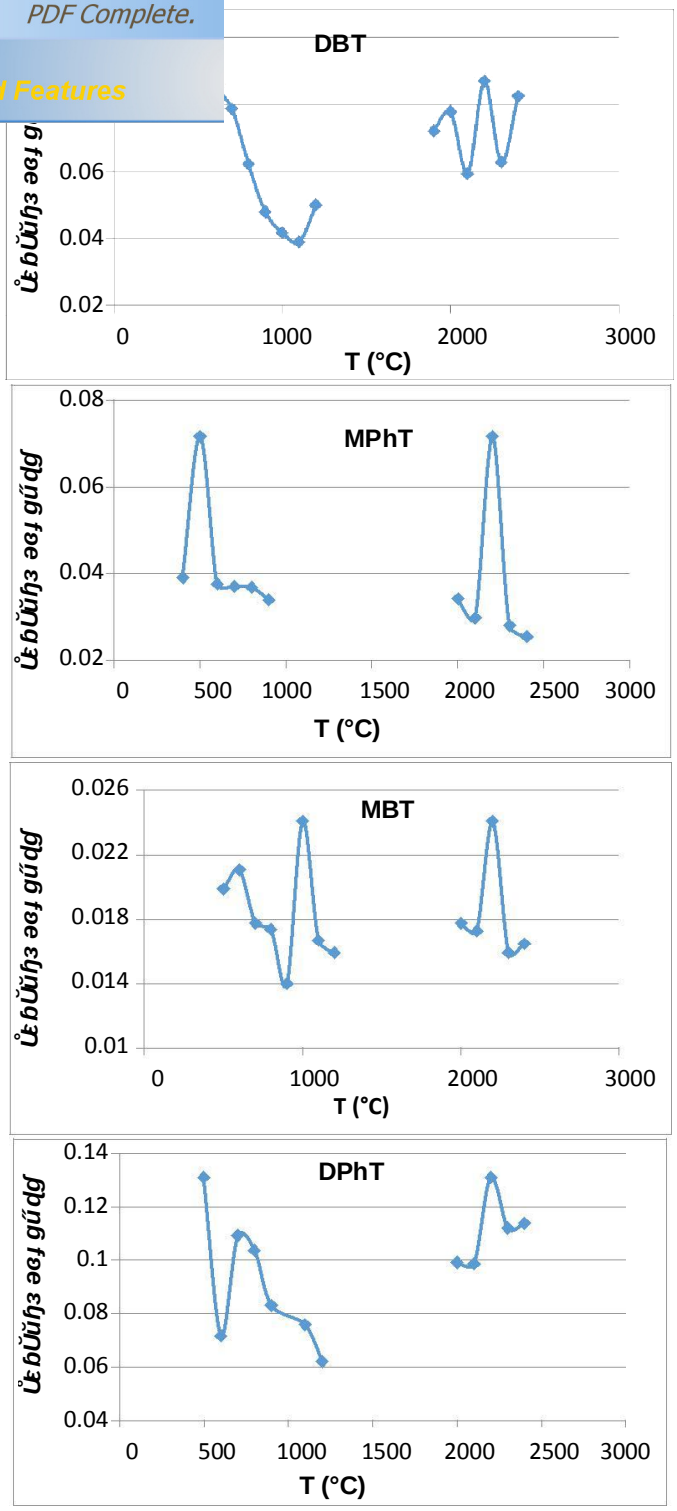

Figure 5.27: : Variation of Mg

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[illegible] Zr [illegible] 200 [illegible] 1300-500 °C [illegible] 2400-1900 °C [illegible]

[illegible]

[illegible] 5.10: [illegible] Zr

[illegible]	[illegible] (°C)	[illegible] (°C)	[illegible] (pg)
TPhT	600	2000	419,5
TBT	500	2200	708,2
DPhT	500	2200	410,3
DBT	500	2200	478,3
MPhT	600	2100	705,4
MBT	500	2100	405,1

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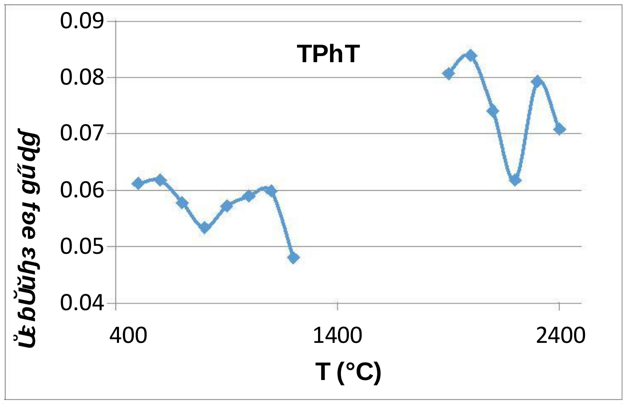
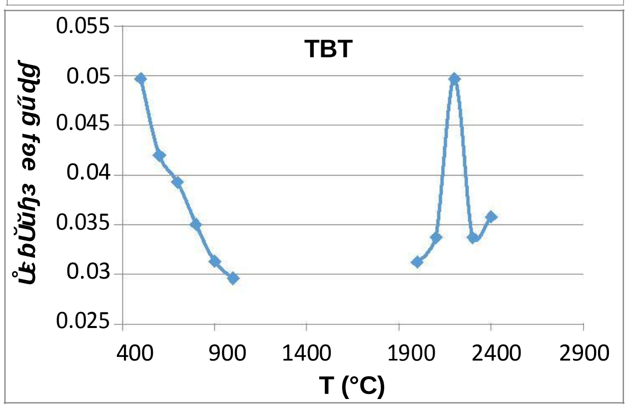
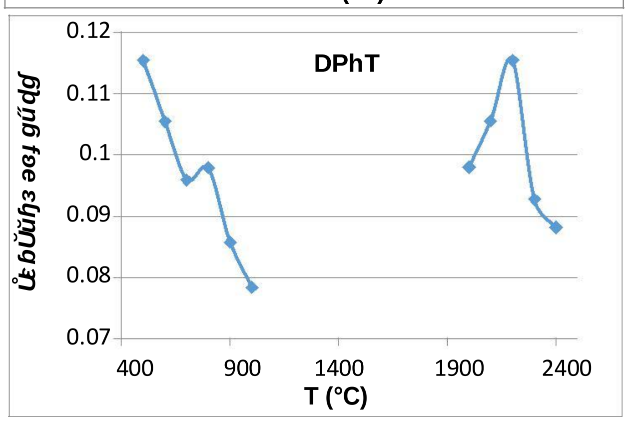
ŰŬəŰŬ ŭɘŬɓɟ Ŭε ε ƳŰŬ ´ gɟ ɧəgůɖɠ/ŬŰɞε ɞ´ ɞɑɖůɖɠ əŬəɔəŬ Űɠ
Űɐů Ůə Űɞg Ůε ɓŬŭɞɨ əɞɟ gűɐɠ ε ŮŮ ɑůŲ ɤ ůɖ Zr.







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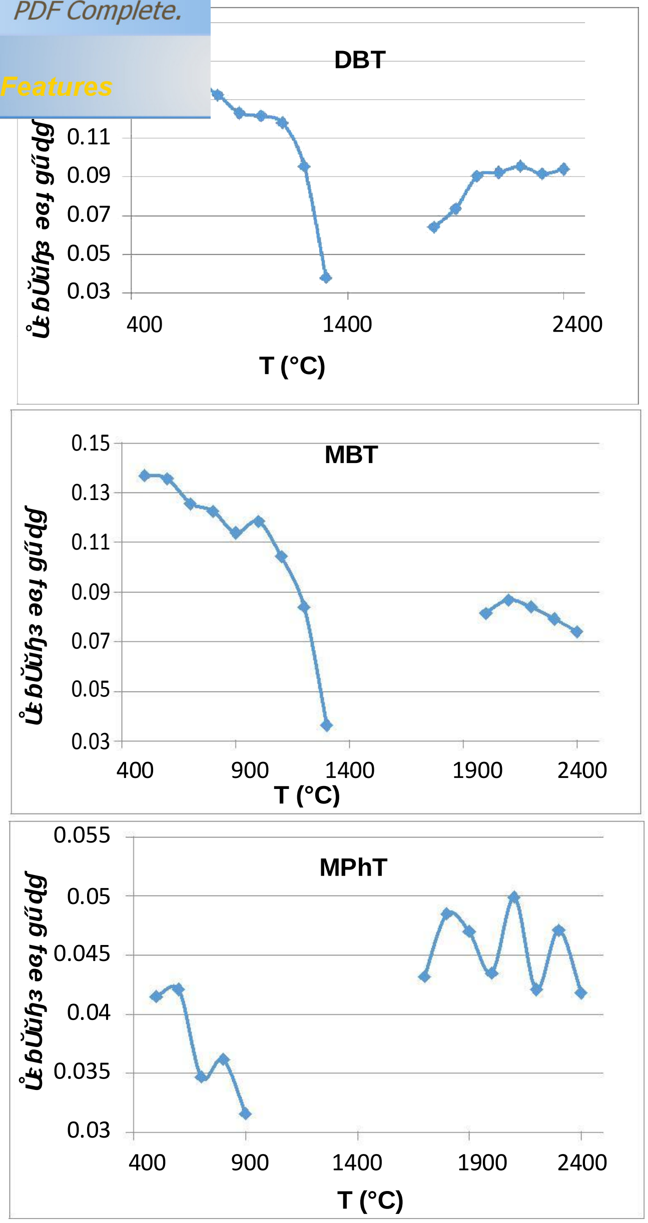

ɆGɐεŬ 5.28: : φǝŬɓɉ ϓεεŬŰŨ ɗŲ̊ εϭǝɉ Ŭů̊ɗŬɠ̊ ůgɜŬɉ Űɇů̊ Ŭ̊ǝŬ̊ε ɓŬŭϭɨ ǝϭɉ gŰɐɠ ɔǝŬ Űɖɜ Ů ɑ̊Ųɉ ɤůɖ Zr

ȼ Ů ɑ̊Ųɉ ɤůɖ εŮ Zr Ŭ́ ϭŭŬ̊ɑGŰɖǝŮ ɤɠ ϭ ´ ǝϭ Ŭ́ ϭŭϭŰǝɧɠ Gɖεǝɧɠ Ųɉ ϭ´ ϭ´ ϭǝɖŰɐɠ Űŭϭɨ ´ Ųɉ Ŭ̊ɑGŮ ´ Ųɉ Ŭ́ ǝɐůǝŮ̊ɠ GŬɉ ŬǝŰɖɉ ǝů Űǝɏɠ εϓɕŮ̊ɠ ǝŬǝɔǝŬ Űǝɠ ɏɜǝϭɉ ɔŬɜϭǝŬůůǝŰŲ̊ɉ ǝɏɠ Ů̊ɜɩ ůŮ̊ǝɠ.

ɄŲɉ ŬǝϓŰɤ ´ Ųɉ ŬŰɑŮ̊ŰŨǝ ůgɔǝŮ̊ɜŲɉ ɤŰǝɧɠ ´ ɑŬǝŬɠ εŮ ɧǝϭgɠ Űϭgɠ Ųɉ ϭ´ ϭ´ ϭǝɖŰɏɠ, ŰŨ Ů̊ε ɓŬŭϓ ǝϭɉ gŰɐɠ ǝŬǝ Űǝɠ GŬɉ ŬǝŰɖɉ ǝů Űǝɏɠ εϓɕŮ̊ɠ ɔǝŬ Űǝɠ ɓɏǝŰǝůŰŮ̊ɠ ɗŲ̊ εϭǝɉ Ŭů̊ɗŮ̊ɠ ´ gɉ ɧǝgůɖɠ/ŬŰɜεϭ´ ϭɑɖůɖɠ ɔǝŬ ǝϓɗŮ̊εǝŬ Ŭ́ ɧ Űǝɠ ɏɜǝϭɉ ɔŬɜϭǝŬůůǝŰŲ̊ɉ ǝɏɠ Ů̊ɜɩ ůŮ̊ǝɠ.

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OT		Au (2,5 εg)	Pd (1,25εg)	Sm (5 εg)	Mg (5 εg)	Rh (5 εg)	Tm (2,5 εg)	Ir (5 εg)	Zr (5 εg)	Zr 120 εg (coating)
TPhT	Εμβαδό κορυφής	0,0773	0,2205	0,1429	0,0913	0,2399	0,1085	0,1150	0,1046	0,0832
	mo(pg)	455,4	170,0	252,0	385,5	146,7	324,4	306,1	336,5	419,5
TBT	Εμβαδό κορυφής	0,0361	0,0859	0,1048	0,0489	0,1517	0,0419	0,0296	0,0904	0,0497
	mo(pg)	975,1	456,0	335,9	1000	276,3	840,1	1200	389,4	708,2
DPhT	Εμβαδό κορυφής	0,1569	0,1903	0,1771	0,1310	0,2105	0,1230	0,1390	0,1686	0,1155
	mo(pg)	410,3	195,2	198,8	268,7	167,2	386,8	253,2	183,7	410,3
MBT	Εμβαδό κορυφής	0,0171	0,0274	0,091	0,0241	0,0732	0,0272	0,1093	0,0616	0,1370
	mo(pg)	3300	1300	386,8	1500	480,9	1600	322,0	571,4	405,1
DBT	Εμβαδό κορυφής	0,0427	0,1463	0,2121	0,087	0,1721	0,0602	0,0672	0,2256	0,1648
	mo(pg)	824,4	260,4	183,0	404,6	204,5	584,7	523,8	156,0	478,3
MPhT	Εμβαδό κορυφής	0,0175	0,0253	0,0627	0,0717	0,0508	0,0176	0,0295	0,0350	0,0499
	mo(pg)	3300	1400	561,4	490,9	692,9	2000	1200	1000	705,4

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[illegible]

[illegible] 2200 °C [illegible] 500/700/900 °C [illegible] 5/10/10 sec [illegible]

[illegible] 5.12: [illegible] 500/700/900 °C [illegible] 5/10/10 sec

[illegible]	[illegible]	[illegible]	[illegible]
TPT	0,0734	0,0195	479,6
TBT	0,0639	0,0163	550,9
DPT	0,1969	0,034	178,8
MBT	0,1650	0,0148	213,3
DBT	0,2107	0,0285	167,1
MPT	0,0531	0,0055	662,9

[illegible] 10/10/5 sec. [illegible]:

[illegible] 5.13: [illegible] 500/700/900 °C [illegible] 10/10/5 sec

[illegible]	[illegible]	[illegible]	[illegible]
TPT	0,0989	0,0083	355,9
TBT	0,0821	0,0069	428,7
DPT	0,2112	0,0195	166,7
MBT	0,165	0,0154	211,4
DBT	0,2175	0,02	161,8
MPT	0,0527	0,0042	667,9

[illegible]

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ĝ ǝ ǝ ɟ Ŭɜ ů ɖ ĝ

ǝŰ ů ǖ ɞ ´ ɞ ɖ ů ɖ ĝ Ű ɖ ĝ ɗ Ů ɛ ɞ ǝ ɟ Ŭ ů ɗ Ű ĝ ǝ ɟ Ŭ ɜ ɖ ů ɖ ĝ. ɖ Ŭ Ű ɖ ɩ ɜ Ű ĝ ů Ű ɗ Ů ɐ Ű ɖ ɗ Ů ɛ ɞ ǝ ɟ Ŭ ů ɗ Ŭ Ű ɞ ɛ ɞ ´ ɞ ɖ ů ɖ ĝ ů Ű ɞ ĝ ĝ 2200°C ǝ Ŭ ǝ Ű ɖ ɜ ɗ Ů ɛ ɞ ǝ ɟ Ŭ ů ɗ ´ ɡ ɟ ɧ ǝ ɡ ů ɖ ĝ ů Ű ɞ ĝ ĝ 600°C Ů ǝ ɔ ɞ ɗ ɖ ǝ Ů ɖ ɗ Ů ɛ ɞ ǝ ɟ Ŭ ů ɗ ǝ ɟ Ŭ ɜ ů ɖ ĝ. ũ ǝ Ŭ ɗ Ů ɛ ɞ ǝ ɟ Ŭ ů ɗ Ű ĝ ǝ ɟ Ŭ ɜ ů ɖ ĝ ´ ɞ ɡ ǝ ɡ ɛ Ŭ ɞ ɜ Ű ǝ Ŭ ɧ 70-90 °C ǝ Ŭ ǝ ɔ ǝ Ŭ ǝ Ɣ ɗ Ů ɛ ǝ Ŭ Ŭ ɧ Ű ĝ ɣ ɜ ǝ ɞ ɟ ɔ Ŭ ɜ ɞ ǝ Ŭ ů ů Ű Ů ǝ ɣ ĝ Ů ɩ ů Ű ĝ ´ ɟ Ŭ ɒ ɛ Ŭ Ű ɞ ´ ɞ ǝ ɖ ɖ ǝ Ŭ ɜ ɛ Ů ɟ ǝ ů Ű ĝ Ű Ŭ Ŭ ɞ Ű ǝ ɣ ů ɛ Ŭ Ű Ű ɜ ɞ ´ ɞ ɜ ´ Ŭ ɞ ɡ ů ǝ Ɣ ɞ ɜ Ű ǝ ů Ű ɞ ĝ ĝ ´ Ŭ ɟ Ŭ ǝ Ɣ Ű ´ ɞ Ŭ ǝ Ů ĝ.

ɄɑŬǝŬĝ 5.14: BŮǝŰů Ű ɞ ´ ɞ ɖ ů ɖ ɗ Ů ɛ ɞ ǝ ɟ Ŭ ů ɗ Ű ĝ ǝ ɟ Ŭ ɜ ů ɖ ĝ ɔ ǝ Ŭ ɇ = 70 °C

ɟ ɜ Ŭǝ Ű ɖ ĝ	Ǻɛ bŬ ŭ ɧ ǝ ɞ ɟ ɡ ű ɐ ĝ	ɉ Ŭ ɟ Ŭ ǝ Ű ɖ ɟ ů Ű ɞ ɖ ɛ Ɣ ɑ Ŭ (pg)
TPhT	0,0888	396,4
TBT	0,0245	1400
DPhT	0,1641	214,5
DBT	0,1844	190,9
MPhT	0,0698	504,3
MBT	0,1662	211,8

ɄɑŬǝŬĝ 5.15: ɗ Ů ǝ Ű ů Ű ɞ ´ ɞ ɖ ů ɖ ɗ Ů ɛ ɞ ǝ ɟ Ŭ ů ɗ Ű ĝ ǝ ɟ Ŭ ɜ ů ɖ ĝ ɔ ǝ Ŭ ɇ = 80 °C

ɟ ɜ Ŭǝ Ű ɖ ĝ	Ǻɛ bŬ ŭ ɧ ǝ ɞ ɟ ɡ ű ɐ ĝ	ɉ Ŭ ɟ Ŭ ǝ Ű ɖ ɟ ů Ű ɐ ɛ Ɣ ɑ Ŭ (pg)
TPhT	0,0886	397,3
TBT	0,0232	1500
DPhT	0,1382	254,7
DBT	0,1746	201,6
MPhT	0,0650	541,4
MBT	0,1524	231,0

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ɞɑɖůɖ ɗŮ ɛɞɘ Ŭůɗŭɠ ɜɐ Ŭɜůɖɠ ɔɕŬ ɇ = 90 °C

ɉ ɜŬɚɨ Ŭɖɠ	Ⱦɛ ɓŬŭɧ ɘɞɉ ɡŭɐɠ	ɟ Ŭɉ Ŭɘŭɖɉ ɕů Ŭɓɖ ɛƳɞŬ (pg)
TPhT	0,0714	493,0
TBT	0,0206	1700
DPhT	0,1183	297,5
DBT	0,1556	226,2
MPhT	0,0558	630,8
MBT	0,1402	251,1

Ʉɑ Ŭɘ Ŭɠ 5.17: ɗŮɚŭɕůŭ´ ɞɑɖůɖ ɗŮ ɛɞɘ Ŭůɗŭɠ ɜɐ Ŭɜůɖɠ ɔɕŬ ɇ = 100 °C

ɉ ɜŬɚɨ Ŭɖɠ	Ⱦɛ ɓŬŭɧ ɘɞɉ ɡŭɐɠ	ɟ Ŭɉ Ŭɘŭɖɉ ɕů Ŭɓɖ ɛƳɞŬ (pg)
TPhT	0,0591	595,6
TBT	0,0174	2000
DPhT	0,1345	261,7
DBT	0,1437	245,0
MPhT	0,0500	704,0
MBT	0,1094	321,8

ɉ ´ ɧ ŬŬ Ŭ´ ɞŭŮɚɤůɛ ŬŬŬ ŭŬɑ ŮŬŬɘɧŬɖ ɗŮ ɛɞɘ Ŭůɗ Ŭ ɜɐ Ŭɜůɖɠ Ů ɗɉ ŮƳɞŬ´ Ŭɉ Ŭ´ ɘɐůɕŬ ɧɘɞɡɠ ŭɡɡ ŬɜŬɚɨ Ŭɖɠ ɘɞŮ ɞɛɤɜɣ ɠ ŭŬ Ů ɕŭŬ ɞɗŬ´ Ŭɉ ɧɛɞɕŬ ůɡɛ´ Ů ɕŭɞɉ Ƴ ɔɕŬ ɧɘɞɡɠ ŭɡɡ ŬɜŬɚɨ Ŭɖɠ.

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[illegible]

[illegible] OTs [illegible] (H_2O_2). [illegible] (1:1) (v/v). [illegible] 1ml [illegible] 65% [illegible] 1ml [illegible] 200 εg/L [illegible]. [illegible] Sn [illegible].

[illegible] 5.18: [illegible] HNO_3 1:1 v/v

ΑΝΑΛΥΤΗΣ	ΣΤΟΙΒΑΔΑ	ΕΜΒΑΔΟ ΚΟΡΥΦΗΣ
TPT	Οργανική Υδατική	0,0651 0,0192
TBT	Οργανική Υδατική	0,0815 0,0192
DPT	Οργανική Υδατική	0,0051 0,0557
MBT	Οργανική Υδατική	0,0180 0,0398
DBT	Οργανική Υδατική	0,0327 0,0621
MPT	Οργανική Υδατική	0,0203 0,0415

[illegible] 5.18 [illegible]:

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ǝǂůḍ ɛŮHNO_3 ůŮǘɞɨ ɟ ɜɞ ɛǝɟ ɞǝgɛ Ὺǘɾ ɜ

	ΣΤΙΒΑΔΑ	ΡΚ
TPT	Ƀɟ ɔǓɜǝǝ Ɉ ŭǓǗǝǝ	0,008 0,2124
TBT	ɞɟ ɔǓɜǝǝ Ɉ ŭǓǗǝǝ	0,2578 0,1201
DPT	ɞɟ ɔǓɜǝǝ Ɉ ŭǓǗǝǝ	0,0093 0,2867
MBT	ɞɟ ɔǓɜǝǝ Ɉ ŭǓǗǝǝ	0,0052 0,2265
DBT	ɞɟ ɔǓɜǝǝ Ɉ ŭǓǗǝǝ	0,7163 0,3126
MPT	ɞɟ ɔǓɜǝǝ Ɉ ŭǓǗǝǝ	0,016 0,6904

ÿ ´ ɤǥ ɔɑŮǕǕǝ ǘǓɜŮ ɧ Ǔ ɧ ǕǕ Ǔ ɞǕǗǝɏůɛǓǕǕ, ḍ ůgɔǝŮǝɟ ɑɏɜḍ ŭǝǓŭǝǓůɑǓ ɛŮ Ǘḍ ɞɟ ɐůḍ Ǘɞg ǘɞɨ ɟ ɜɞg ɛǝɟ ɞǝgɛ Ὺǘɾ ɜ ɐǕǕɜ Ǔ ɞŭɞǗǝɧǕǕ ḍ ůŮɗɏɛ Ǔ ŭǝǓɞɤ ɟ ǝůɛɞɨ ɞɟ ɔǓɜǝǝɞ-gŭǓǗǝɞǥ ǘ Ὺůḍǥ ɔǝǓ ǕǕ TPT,DPT,MBT,MPT ɧɞǝɧɛɤǥ ǝǓǝɔǝǓ ǕǕ TBT ǝǓǝ DBT. Ɇǘḍ ůgɜɏɞŮǝǓ ůŮůgɜŭgǓǕůɛɧ ɛŮ g´ Ǘɟ ɞɜŮǓŭǝ Ǘɞg gŭɟ ɞɔɧɜɞg (H_2O_2) ´ ɟ Ǔǝɛ ǓǗɜ´ ɞɐɗḍǝǓɜ ɛǓǕɟ ɐůŮǥ ůŮŭɨ ɞ Ů ɑ ǓǗǓ. ɟ ɟ ɞǝ Ὺ ɛŮ ŭǝǓǝgǗɜ´ ɞɗůḍ 2ml ȼ ʔɃ ₃ ůgɔǝɏɜǕɟ ɤ ůḍǥ 65%, 2ml H_2O_2 ǝǓǝ 2ml ´ ɟ ɞǗ ´ ɞg ůgɔǝɏɜǕɟ ɤ ůḍǥ 200 ɛg/L ŭǝǓǝgɛɏɜɞ ůŮ Ǘɜǝɞgɧǝɞ (ɔǝǓ ǝὙɗŮ ɛǝǓ Ǔ ɧ Ǘǥ 6 Ůɜɩ ůŮǥ ǘɾ ɜ ɞɟ ɔǓɜɞǝǓůůǝǕǕɟ ǝɩ ɜ) ŮǝɐǘɗḍůǓɜ ǕǕ ´ Ǔɟ ǓǝὙǘɾ Ǔ ɞǕǗǝɏůɛǓǕǕ Ǔ ɧ ǕǕ ɞ´ ɞɑǓ Ǔ ɞŭŮǝɜɨ ǕǕǝ ɧǘǝ ḍ Ǔ ɧŭɞůḍ Ǘḍǥ Ůǝɞɨ ǝǂůḍǥ Ǔgɜɐɗḍǝ Ůůḍɛ ǓɜǗǝὙ.

Ʉɑ̆ǕǝǓǥ 5.20: Ǻǝɞɨ ǝǂůḍ ɛŮHNO3 ǝǓǝȼ $_2O_2$ 1:1 v/v

HNO_3/H_2O_2/ΠΡΟΤΥΠΟ 1:1:1 v/v/v		
ΑΝΑΛΥΤΗΣ	**ΣΤΙΒΑΔΑ**	**ΕΜΒΑΔΟ ΚΟΡΥΦΗΣ**
TPT	Ƀɟ ɔǓɜǝǝ Ɉ ŭǓǗǝǝ	0,0083 0,1905
TBT	Ƀɟ ɔǓɜǝǝ Ɉ ŭǓǗǝǝ	0,0188 0,1067
DPT	Ƀɟ ɔǓɜǝǝ Ɉ ŭǓǗǝǝ	0,0200 0,2098
MBT	Ƀɟ ɔǓɜǝǝ Ɉ ŭǓǗǝǝ	0,0076 0,1623
DBT	Ƀɟ ɔǓɜǝǝ Ɉ ŭǓǗǝǝ	0,0373 0,1197
MPT	Ƀɟ ɔǓɜǝǝ Ɉ ŭǓǗǝǝ	0,0057 0,7341

Ǻ´ ɑůḍǥ ɗǓ ´ ɟ ɏ´ ŮǝɜǓ Ǘɜɜǝǂ ǕǕǝɧǗǝŮǝɏɔɞɗḍǝŮǝǓǝɞ ɞɟ ɧɜɞǥ Ǔ´ ɞɗɐǝŮǥůḍǥ ǘɾ ɜ ŭǓǝɛὙǘɾ ɜ ůǗḍɜ ǝǓǗὙ gɜḍ ɩ ůǕǕɜǓ Ǔ ɞǓŭǝɗŮɑɞ Ǔ Ǔǝɞɨ ɛŮɜɞǥ ɞɟ ɧɜɞǥ ǓɜὙǝgůḍǥ. ɑǝǓ´ ǝǂ Ǘɨ ɗḍǝŮɧǗǝǕǕ ŭǓǝɛǓǕǕ

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ɠ ǘŬϭŮŰŰǝɧŰϭg΄ Ɣɉ ϭϭgɜ ůḓɛŬɜŰǝɏɠ ŭɕŬǘϭɉ ϭ΄ ϭǝůŮɠ ůŮ

ɉ ΄ ɧ Ůḓ ůŰǝɛɐ ΄ ϭg ɛŮ Űϭ ůgɜǔgŬůɛɧ Űɤɜ ůgɔǝŮǝɉ ɛɏɜɤɜ ŮǝϭgǝůŰǝ ɜ ɛɏůɤɜ ŮǝɐǘḓḓůŬɜ ǝŬɜϭ΄ ϭǝḓŰǝƔ Ŭ΄ ϭŰŮǝɏůɛŬŰ, ΄ ɉ Ŭɓɛ Űϭ΄ ϭǝḓḓǝŬɜ ŭϭǝɛɏɠ ŭɕŬǘϭɉ ŮŰǝ ɜ ŬɜŬǝϭɔǝ ɜ ŮǝϭgǝůŰǝ ɜ ɛɏůɤɜ ǝŬǝ Űϭg ΄ ɉ ϭŰ ΄ ϭg ΄ ɉ ϭǝŮǝɛɏɜϭg ɜŬ ɓŮǝŰůŰϭ΄ ϭǝḓŮ ϭ ɧɔǝϭɠ Űϭg ŮǝϭgǝůŰǝϭɨ ɛɏůϭg ϭɤɉ ḓ ɧɛɤɠ ɜŬ ΄ ɉ ϭǝɨ ΄ Űϭgɜ ǝŬɜϭ΄ ϭǝḓŰǝƔ Ŭ΄ ϭŰŮǝɏůɛŬŰ. ɇŬ Ŭ΄ ϭŰŮǝɏůɛŬŰ ΄ Ŭɉ ϭgůǝƔϭɜŰǝůŰϭgɠ΄ Ŭɉ ŬǝƔŰɤ ΄ ϭŬǝŮɠ:

ɄϭŬǝŬɠ 5.21 : ɀ Ůɉ ɐůŮɠ gǔŬŰǝɐɠ-ϭɉ ɔŬɜǝɐɠ ǘƔůḓɠ ɛŮHNO_3 ǝŬǝH_2O_2 1:3 ǝŬǝ500ɛl Ŭ ɧ ΄ ɉ ɧŮ΄ ϭ ůgɔǝɏɜŮ ɤůḓɠ 200ɛg/l ŭɕŬǝgɛɏɜϭ ůŮŰǝϭgɧǝϭ

ɉ ɜŬǝɨ Ůḓɠ	Ⱥɛ ɓŬǘɧ ǝϭɉ gǘɐɠ gǔŬŰǝɐɠ	Ⱥɛ ɓŬǘɧ ǝϭɉ gǘɐɠ ϭɉ ɔŬɜǝɐɠ
TPhT	0,2671	0,0446
TBT	0,2844	0,0599
DPhT	0,1367	0,0593
DBT	0,1064	0,0082
MPhT	0,1434	0,0140
MBT	0,2254	0,0200

ɄϭŬǝŬɠ 5.22: ɀ Ůɉ ɐůŮɠ ϭɉ ɔŬɜǝɐɠ-gǔŬŰǝɐɠ ǘƔůḓɠ ɛŮHNO_3 ǝŬǝH_2O_2 1:1 ǝŬǝ500 ɛl Ŭ ɧ ΄ ɉ ɧŮ΄ ϭ ůgɔǝɏɜŮ ɤůḓɠ 200ɛg/l ŭɕŬǝgɛɏɜϭ ůŮŰǝϭgɧǝϭ

ɉ ɜŬǝɨ Ůḓɠ	Ⱥɛ ɓŬǘɧ ǝϭɉ gǘɐɠ ϭɉ ɔŬɜǝɐɠ	Ⱥɛ ɓŬǘɧ ǝϭɉ gǘɐɠ gǔŬŰǝɐɠ
TPhT	0,0480	0,3965
TBT	0,0933	0,4497
DPhT	0,0192	0,4582
DBT	0,0255	0,1097
MPhT	0,1856	0,2690
MBT	0,2629	0,3022

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[illegible] 10 mg/L [illegible] 200 εg/L. [illegible]

[illegible] 5.23: [illegible] 200εg/L [illegible]

[illegible]	[illegible]	[illegible] (pg)
TPhT	0,4516	77,9
TBT	0,4473	78,7
DPhT	0,4217	83,5
DBT	0,3529	99,7
MPhT	0,2199	160,1
MBT	0,4250	82,8

[illegible]

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[illegible] HNO_3 [illegible] H_2O_2 1:1(v/v) [illegible] 200 mg/l [illegible]

[illegible]	[illegible]	[illegible] (pg)
TPhT	0,1682	195
TBT	0,0955	368,6
DPhT	0,0855	410,4
DBT	0,0836	421,1
MPhT	0,1228	286,6
MBT	0,1109	317,4

[illegible] 5.24

[illegible] 5.25: [illegible] 500 mL

[illegible]	[illegible]	[illegible]	[illegible]
1	0,1101	0,0084	319,7
2	0,1073	0,0087	325,4
3	0,1192	0,0129	295,3
4	0,1565	0,0096	224,9
5	0,1169	0,0093	301,3
6	0,1111	0,0087	316,8

[illegible]

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[illegible] 2 L [illegible] 25 g NaCl, 50 ml CH_3COOH [illegible] 100 [illegible] 10 mg/L [illegible] 10 ml [illegible] 15 min [illegible] 10 ml [illegible] Teflon [illegible] 2 ml [illegible] 65%, 2 ml H_2O_2 [illegible] 500 [illegible] 15 min [illegible] 5.26.

รูปที่ 5.26: [illegible] 2 L [illegible] 25 g NaCl, 50 ml CH_3COOH (100% v/v) [illegible] 100 [illegible] (200 [illegible]/L) [illegible]

[illegible]	[illegible]	[illegible]
TPhT	0,0301	1100
TBT	0,0293	1100
DPhT	0,0211	1500
DBT	0,0154	2100
MPhT	0,0089	4000
MBT	0,0192	1800

[illegible] MPhT, [illegible]

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ɜ Ǘɤɜ ǓɜǕǙ Ǖů Ǘɖ ɑɜ ˊ ɟɏˊ ǘɜǓ ǘɜǓɘ 500 ml ǔǘɛǓǗɕɠ,

ǓɑǓɘǓɠ 5.27: ɀ ɏǙ ɖůɖ ɀ PhT ɛǗɛɐǙ Ǔ 1 L, 12,5 g NaCl, 25 mL CH_3COOH (100% v/v) ɘǓɘ ǘɛ ɓɕɘǓůɛɧɠ ɛǗ100 ɛL ˊ ɟɕǙ ˊ ɕg (200 ɛg/L)

ɟ ɟ ɖɛɧɠ ɀ ɏǙ ɖůɖɠ	Ⱥɛ ɓǓǔɧ ɘɕɟ ɡǗɐɠ	ɟ Ǔɟ Ǔɘ Ǘɖ ɟ ů Ǘɐ ɛ ƳɕǓ
1	0,0323	1100
2	0,0281	1300
3	0,0274	1300
4	0,0235	1500

ǓɑǓɘǓɠ 5.28: ɀ ɏǙ ɖůɖ ɀ PhT ɛǗɛɐǙ Ǔ 0,5 L, 12,5 g NaCl, 25 mL CH_3COOH (100% v/v) ɘǓɘ ǘɛ ɓɕɘǓůɛɧɠ ɛǗ100 ɛL ˊ ɟɕǙ ˊ ɕg (200 ɛg/L)

ɟ ɟ ɖɛɧɠ ɀ ɏǙ ɖůɖɠ	Ⱥɛ ɓǓǔɧ ɘɕɟ ɡǗɐɠ	ɟ Ǔɟ Ǔɘ Ǘɖ ɟ ů Ǘɐ ɛ ƳɕǓ
1	0,0443	794.6
2	0,0432	814.8
3	0,0399	882.2
4	0,0431	816.7

ɟ ˊ ɧ Ǘɖ ůǗɐɛɐ ˊ ɕg ǔɜǓ ˊ ɖ Ǘ ɖɖɘǗ ɧǗɘ ůǗǓ 500 mL ɛɐǙ Ǔɠ ǔǘɛǓǗɕɠ Ǘɜ ɀ PhT ˊ Ǔɟ ɕgůɖǓɛǗ Ǔgɜɖɛɏɜɖ ǗgǓɘůɖɖůɖǓ ůǗůɕɏůɖ ɛǗǓǓ 2 L ɛɐǙ Ǔɠ ǔǘɛǓǗɕɠ,ˊ ɟ ǓɛǓǗɜˊ ɕɐɖɖɘǓɜ ɛǗǙ ɐůǗɠ ɛǗ Ǘɖɜ ɖɘǓ ǔɘǓɘǓůɖ ɘǓɘɔɘǓ Ǘɠ ɏɜɘɕɟ ɔǓɜɕɘǓůůɘǗɟ ɘɏɠ ǗɜɩůǗɠ.ɇǓ Ǔ ɕǗɘůɛǓǓ ˊ Ǔɟ ǓǗɖǗɜǓɘ ůǗɜɜ ˊ ɑǓɘǓ 5.29.

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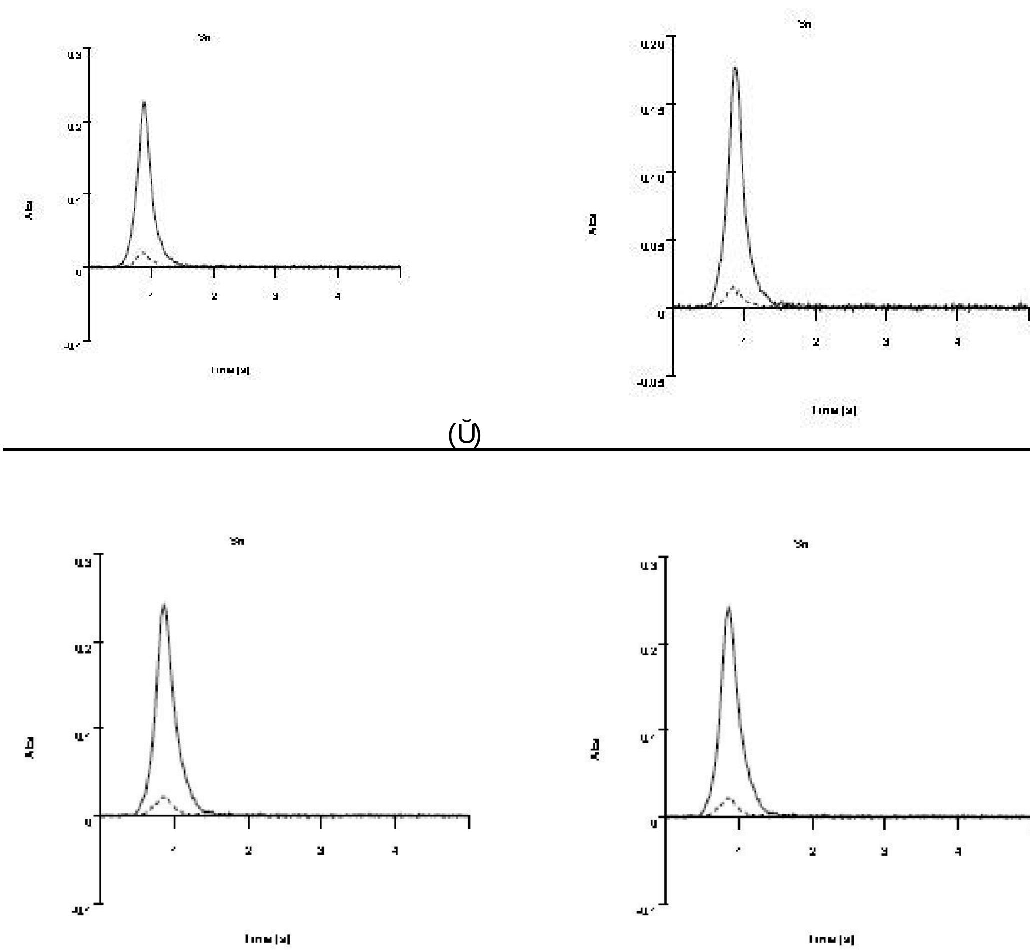
Ŭṙ з OTĉs ɛŮŰď ŭsŬŭsəŬůďŬ Ŭsg ŰŮbəoɕɨ ´ ɟ ɤ Ŭsəђəəɛg

	Ŭŭђ əɕɟ gűɐɠ	ɟ Ŭɟ ŬəŰďɟ sůŬbəɛ ɛ ϔɛŬ
ǿPhT	0,0687	550,7
TBT	0,0536	661,5
DPhT	0,0763	455,4
DBT	0.0592	596,6
MPhT	0,0598	590,2
MBT	0,0799	451,3

ɄŬɟ ŬŰďŰ ůsŬŰbəŬŬ ŮɛbŬŭϒ əɕɟ gűɐɠ ɔəŬ Űsɠ ŰŮbəɣɠ ɛ ŬŰɟ ɐů Ůsɠ



(Ŭ) (b)

(ɔ) (ŭ)

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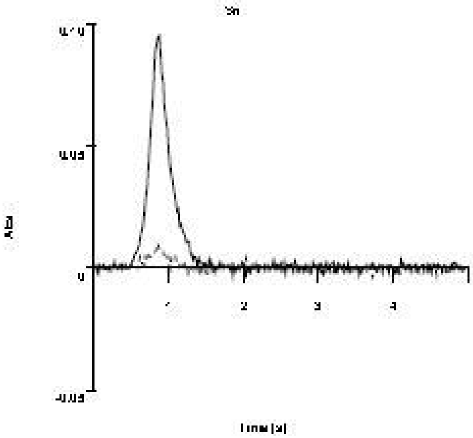
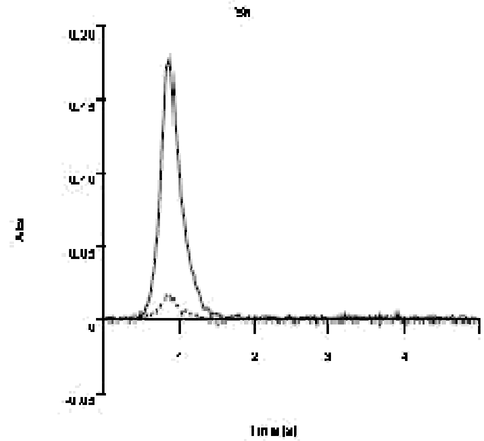


(Ů)



(ůŰ)

Ɇɢɚɛ Ŭ 5.29: ɹ ˊ ɞɻ ɻ ɞǘɐůŮɡɠ ǝŬɔɕŬ Űɡ ɏɜɕɞɻ ɔŬɜɞǝŬůůɕŰɻ ɕɏɠ Ůɜ ůŮɡ ůɨ ɛǘɤ ɜŬ ɛŮŰɸ ɛɏɗɞŭɞ ˊ ɞɡ ˊ Ůɻ ɕɻ ɣǘ ŮŰŬɕůǘɞ ŰŮɕɳ ˊ ɻ ɤ Űɳɕɞɕɕɞ. Ŭ) TPhT, ɓ) TBT, ɔ) DPhT, ŭ) MBT, Ů) MPhT, ůŰ) DBT

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Ůŕ ɜ ɖ ɛᵻɗɞŭɞɠ ˊ ɞɡ ŰŮɚɘƳ ɕɟ ɖůɕɛɞ ˊ ɞɕɗɖɘŮ ɔɕŬ Űɞɜ ˊ ɟ ɞůŭɕɟ ɕůɛɧ Űŕ ɜ ɕɟ ɔŬɞɞɘŬůůɕŰŲɕɩ ɜ Ůɞɩ ůŮŕ ɜ ˊ Ųɕ ŮɘƳɛɓŬɞŮŰŬ Ůɞɡ ůŰƳŭɕŬ (Ŭ) Ʉɟ ɞůɗɘɖ 500 ml ŭŮɒɛŬŰɞɡ ůŮ ɞɞƳɜɖ ɛŬɑɑɛŮ 25ml CH_3CHOOH (100% v/v), 12 g NaCl ɘŬɘ 10 ml Űɞɘɞɡɧɘɞ. ɁŬŰɧ ˊ ɕ ŬɘɞɘɞɡɗŮɑɜŰɞɜɖ ŬɞƳŭŮɡůɖ (b) Ʉɟ ŬɒɛŬŰɞ ˊ ɞŮŰŰɘŭɕŬɞɤ ɟ ɕůɛɧɡ ŭƳůŮŕ ɜ ɘŬɘ ŮɞƳŰɛɕůɖ ůŮ ŭɘƳŰŰɞɖ Ŭɑ Űɞɡ ɛᵻɕɟ ɘ ɜɖɟ ɞɨ. (ɔ) ɟ ɘɞɘɞɡɗŮɑ Ů ŬɞŬŭɕŬɘɡŰɞ ˊ ɞɖůɖ Ŭ ɧ 1-10 ml ŮɞƳɜɕ (ŬɞŬɘɧɔɤɡ Űɞ ˊ ɧůɞ ɕŬɛɖɘƳ ɧɟɕŬ ůɡɔɘᵻɜŰŕůɖɡ ɗᵻɘɤ ɜŬ ˊ ɟ ɞůŭɕɟ ɑŮɤ) (ŭ) ɟ ˊ ɧ ŬɡŰƳ ɘŬɛɓƳɜɞɜŰŰɘ 500 ɛl ŰŰ ɞ ˊ ɞɗŬ ɛŬɑɑɛŮ 2 mL H_2O_2 ɘŬɘ 2 mL HNO_3 Űɞ ˊ ɞɗŮŰɞɨ ɜŰŰɘůŮŭɞɞŮŬ Teflon ɘŬɘŬɘɞɘɞɡɗŮɑŮɚɞɨ ɘɕůɖ ůŮŰɞɨ ɟ ɜɞ ɛɕɟ ɞɘɡɛƳŰŕ ɜ (ˊ ɕŬɘŬɡ 5.30) (Ů) ŬɘɞɘɞɡɗŮɑ ˊ ɟ ɞůŭɕɟ ɕůɛɧɡ ɘŬůůɕŲɟ ɞɡ ɛŮ Űɖ ɕɟ ɐůɖ Űɞɡ ŰŬůɛŬŰɧɛŰŲ ɞɡ ŬŰɞɛɕɐɡ Ŭ ɞɟ ɟ ɧŰɖůɖɡ ɛŮ Ů ɕůŲ ɤ ɛᵻɜɞ ɛŮ ɕɟ ɘɧɜɕ Űɞɨ ɟ ɜɞ ɖɘŮɘŲ ɞɗŮɟ ɛŬɕɧɛŮɞɞɡ ɔɟ ŬŰɗŮɖ ɛŮ ɗŲ ɛɞɘɟ ŬůɗŬ ˊ ɡɟ ɧɘɡůɖɡ 900 °C ɘŬɘ ɗŲ ɛɞɘɟ ŬůɗŬ ŬŰɞɛɞ ˊ ɞɖůɖɡ 2200 °C

ɄɑɞŬɘŬɡ 5.30: Ʉɟ ɧɔɟ Ŭɛɛ Ŭ Űɞɨ ɟ ɜɞɡ ɛɕɟ ɞɘɡɛƳŰŕ ɜ

Power (W)	Ramp time (min)	Control Temperature (ºC)	stirring	Hold time (min)
800	3:00	80	3	2:00
800	5:00	90	3	5:00

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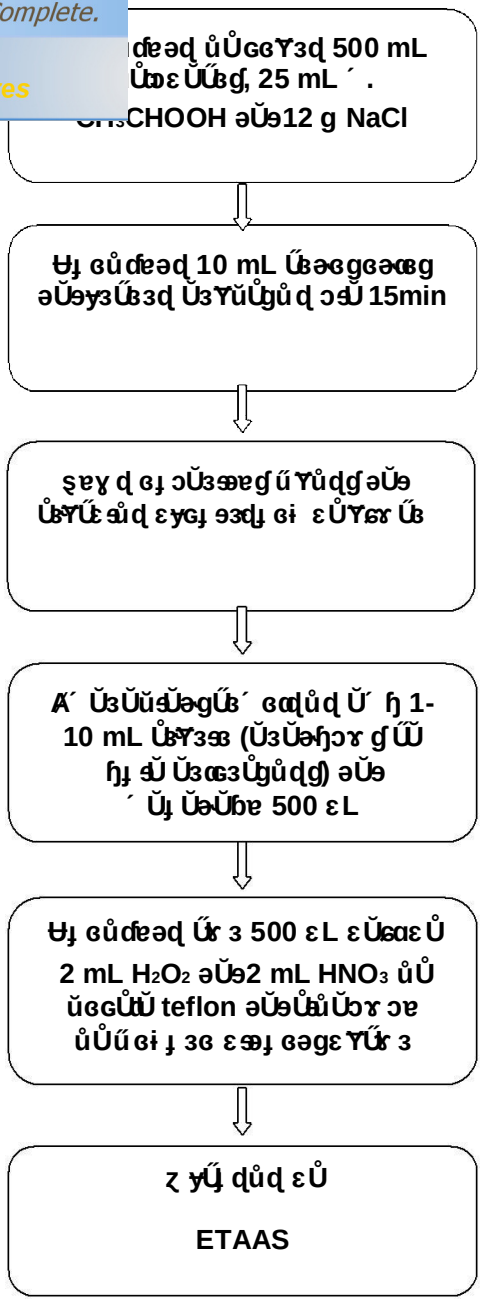

Ɛœɛ Ü 5.30: Hȷ ɤ Űɦəgəəœ ɛÛdɦügg

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[illegible] 6

[illegible]

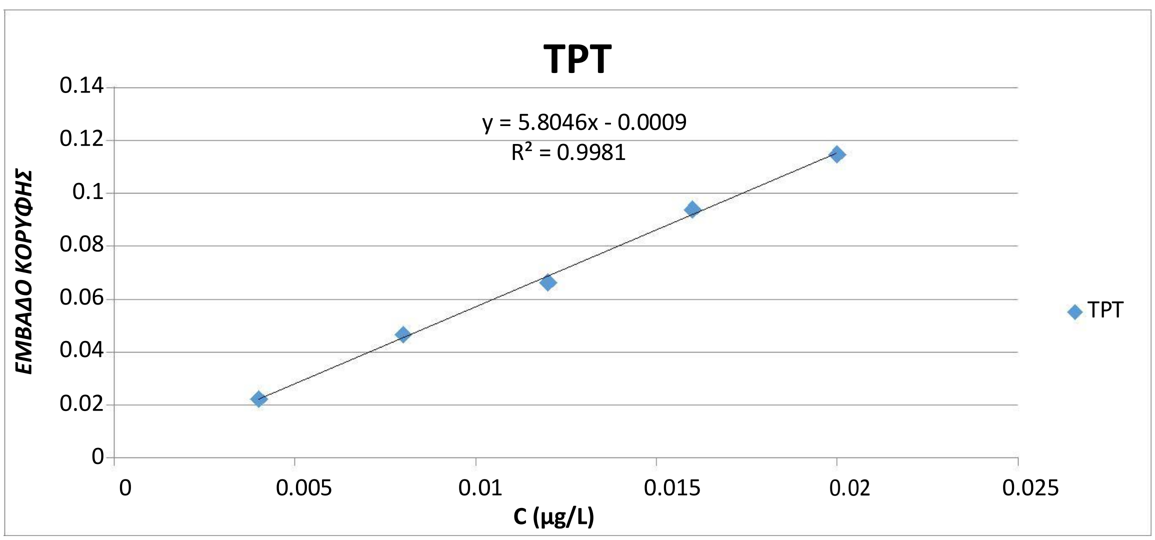
6.1 [illegible]

[illegible]

[illegible] 6.1: [illegible]

C (ng/L)	TPhT	TBT	DPhT	DBT	MPhT	MBT
5	0,0222	0,0192	0,0212	0,0197	0,0199	0,0220
10	0,0467	0,0437	0,0427	0,0398	0,0407	0,0379
15	0,0664	0,0617	0,0644	0,0589	0,0596	0,0549
20	0,0938	0,0827	0,0860	0,0792	0,0768	0,0782
25	0,1148	0,1023	0,1105	0,1011	0,1016	0,1006

[illegible]



[illegible] 6.1: [illegible] TPhT

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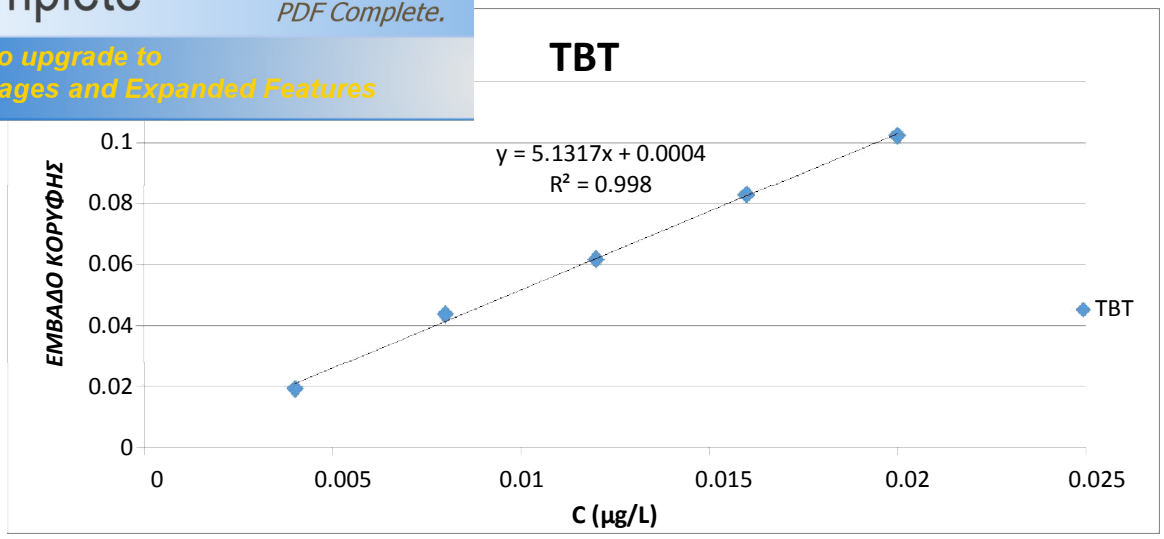
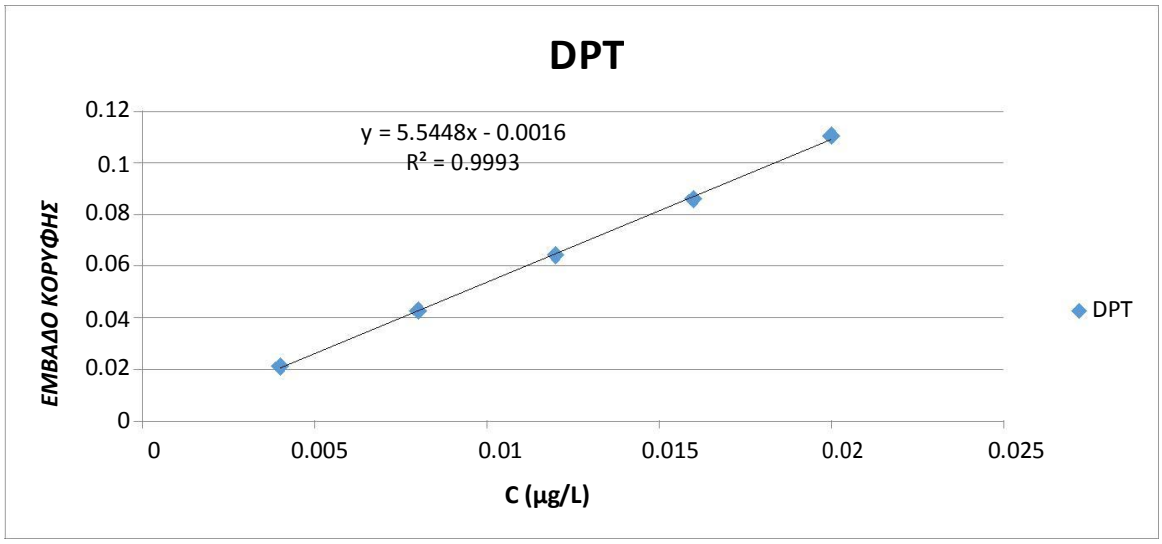


Εικόνα 6.2 : Γραφική παράσταση για TBT



Εικόνα 6.3 : Γραφική παράσταση για DPhT

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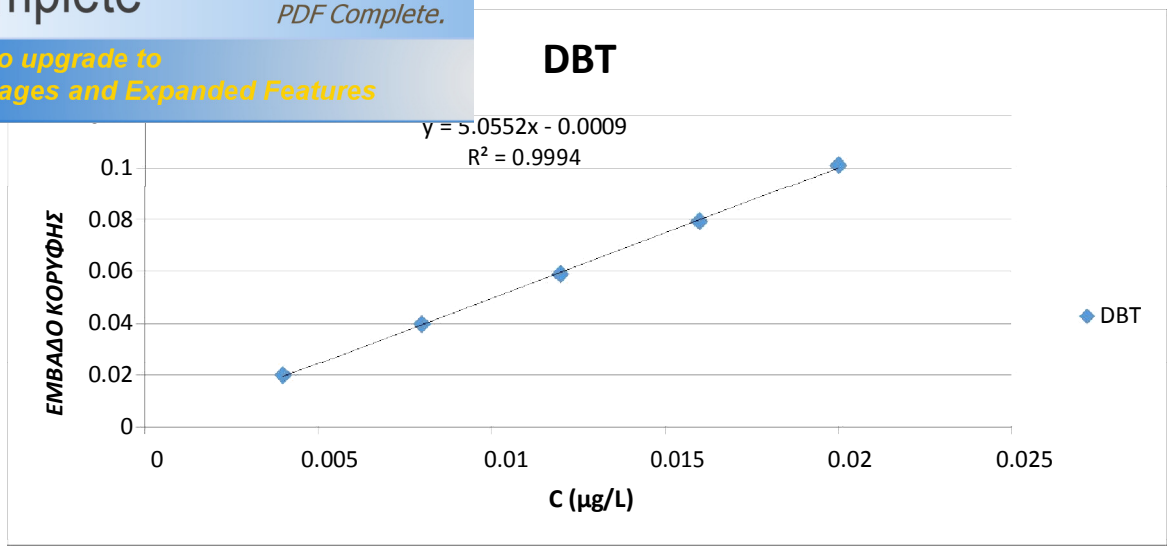
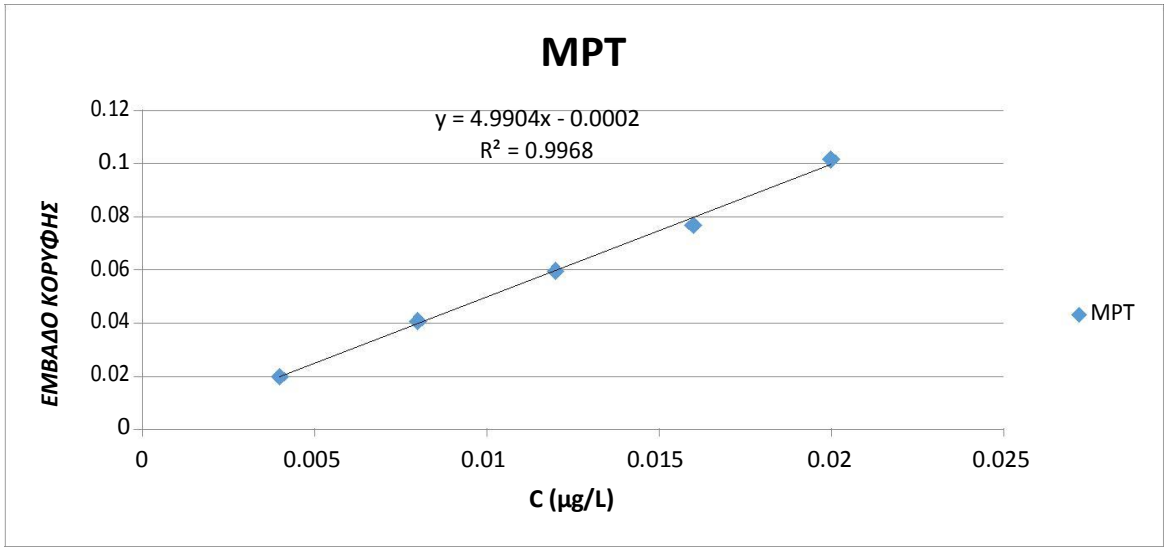


Εικόνα 6.4 : Γραφική απεικόνιση της καμπύλης βαθμονόμησης



Εικόνα 6.5: Γραφική απεικόνιση της καμπύλης βαθμονόμησης για PhT

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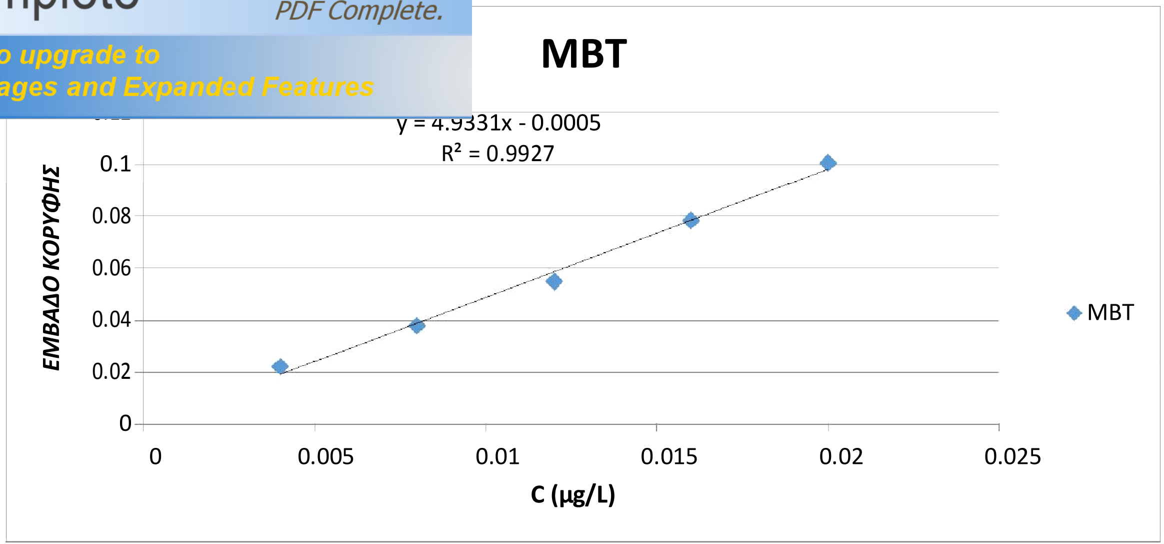

Ɇɛɚɛɛ 6.6: ⅄Ǔɛ΄ɨ ǝɖ ǓɜǓǘɞɟ Ɣɠ ɔɘǓǘ ȼPhT

ɟ΄ɧ ǘɠ ǝǓɛ΄ɨ ǝǘɠ ǓɜǓǘɞɟƔɠ ǘǓɞǘǘǘɘ ɧǘɠ΄Ɣɟ ɞǘɘ ɔɟ Ǔɛɛɘɧǘǘǘ ǘɞ ɞ΄ɞɞ Ǔ ɞǘǘɘɜɨ ǘǘǘɘ ǝǓɘ Ǔ ɧ ǘɞ ǘɡɜǘǘǘǘɟ ǘɡǘɞɣǘǘɖɠ. Ƀ ǘɡɜǘǘǘǘɠ ΄ɟɞǘǘɘɟǘɛɞɨ (R^2) ΄ɟɣ ǘɘ ɜǓ ǘɞǓɘ ɛǘǘǓɘ ǘǘɟɞɠ Ǔ ɧ 0,98 (΄ɟɞǘɞƔǘǘɘ ǘɞ 0,99 ǓɘǝƔ ǝǓɘǘɞ 0,98 ǘɞǓɘǓ ɞǘǘɘǘɧ, ǘɘǓɟǘ ɛǘɞɞ Ǔ ɧ ǘɠ ǓɜƔɔǝǘɠ ǘɖɠ ɛǘǘɧǘɞɡ). ɟ ɜǘǘǘɞɛǓ ɞ ǘɡɜǘǘǘǘɠ ǘɡǘɞɣǘǘɖɠ (R) ɖǓ ΄ɟɣ ǘɘ ɜǓ ǘɞǓɘ ɛǘǘǓɘ ǘǘɟɞɠ Ǔ ɧ 0,997. ɟ΄ɧ ǘǓ ΄Ǔɟ Ǔ΄ Ɣɜɤ ǘɞɛɛǓǘǘ ǘǓɞǘǘǘɘ ɧǘɘ ǝǓɘ ɞɘ ǘɨ ɞ ΄ǓɟƔɛǘǘ ɞɘ ɘǓɜɞ΄ɞɘɨ ɜǘǘɘ Ȧ΄ǘɖɠ ǘɞ ǘɖɛǓɜǘɘɧ ΄ɞɠ ΄Ǔɟ Ǔǘɖɟ ɐɖɖǝǘ Ǔ ɧ ǘɠ ΄ǓɟǓ Ɣɜɤ ǝǓɛ΄ɨ ǝǘɠ ǓɜǓǘɞɟƔɠ ǘǓǓɘɧǘɘɧǝǘɠ ɞǝǝǘǘɠ ǘǘɞ ǘɘǓǘɣɟ ɞɡɜ ǘɖɛǓɜǘɘƔ ǝǓɘǘ ɞɛɣɜɤ ɠ ɛǘǘɞ ǘɡɔǝǘɘɟ ɘɣɜɞ ΄ɟɤ ǘɧǝɞǝǝɞ ɘǓɜɞ΄ɞɘǘǘǘɘɖ ΄ɘ ɓǘǘɘɐ Ǔɟɞɐ ɩ ǘǘǘ ɜǓ ǘ ɘǘǘɠɞɖǘɞ ΄ɟɞǘǘɘɟǘɛɧɠ ɞǝɘɩ ɜ ɞɟ ɔǓɜɞǝǘǘǘǘɟɘɩ ɜ ǘɩ ǘǘɤɜ.

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D εŮďŋŭϲg)

ŭŝŬ Ŭϐƺ g´ ϐǝϐɔϩŝεŋ Ŭϐg ϐʇ ϖg Ŭƺϖƺ Ůgůďƍ Ŭďƍ εŮďŋŭϲg εŮĵ ʁďǝŮď Ŭ´ ϐʇ ȷ ŋŭďůď Ůƺŋƍ ǝŬgǝϐɨ ŭŮɒεŬŬϐƍ 10 ŭϐʇ ɏƍ. ɆŬď ůgɜɏϲŬŝ g´ ϐǝϐɔϩŬďǝŮϐ εɏůϲƍ ŋʇ ϐƍ Ŭgŭ ɜ ǝŬǝď Ŭg´ ϩɐ Ŭ´ ŋǝǝϩď.
Ʉϐǝǝ Ŭ´ ǝŬůɕɏůŬďǝŮ3,3 ŭϐʇ ɏƍ ď Ŭg´ ϩɐ Ŭ´ ŋǝǝϩď ǝŬǝŭŝŬɟ ɏďďǝŮεŮŬϐɜ εɏůϲ ŋʇ ϐ Ŭɾ ɜ ǝǝϩůŬɾ ɜ
Ŭɾ ɜ ǝŬε´ gǝɨ ɜ ŬɜŬŭϐʇ Ɏƍ´ ϐg g´ ϐǝϐɔϩŬďǝŬɜ ɔŝŬ Ŭď ɔʇ ŬεεϩŋŬďŬŬ Ŭďƍ εŮďŋŭϲg. ȮŬůǝǝʁŭďďǝŮ
εŝŬ Ŭϩεʁ ´ ϐg Ŭ´ ϐŬŬǝŬŭϐ ŋʇ ϖ ŬɜϖɜŮgůďƍ Ŭďƍ εŮďŋŭϲg.

ɄϖŬǝŬƍ 6.2: ȳ ȷ ŝŬ Ŭɜϖɜ Ůgůďƍ

Ά´ ŬɜɎǝďɣ ď	**Άε ϸŬŭŋɜ ǝϐʇ gŭʁƍ**
1	0,0006
2	0,0004
3	0,0006
4	0,0012
5	0,0010
6	0,0004
7	0,0007
8	0,0002
9	0,0003
10	0,0008
SD	0,00032
3.3 SD	0,00106
LOD	0,0002 εg/L

ɇϐ ŋʇ ϩ Ŭɜϖɜ Ůgůďƍ ǝʇ ϖŬŬǝŭŝŬŬ Ŭ ϩŬɜϐ´ ϐϩŬŋ ůŮůϲɏůď ǝŬε ŮŬ ɜϐεϐďŬŋ ŋʇ ϩ OTs ůŮ
ɜŮ Ɏ.

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6.3.1 [illegible]

[illegible] 5.5. [illegible] 500 mL [illegible] 12 g NaCl [illegible] 25 mL [illegible] 100 [illegible] 10 mL [illegible] 15 min. [illegible] 10 mL [illegible] 500 [illegible] Teflon [illegible] 2 mL [illegible] 2 mL [illegible] 20 min [illegible] Sn [illegible] g/L, [illegible] (6.3) [illegible]

[illegible] 6.3: [illegible]

[illegible]	[illegible] g/L	SD g/L	%RSD
TPhT	1,656	0,064	3,8
TBT	1,76	0,21	12
DPhT	1,663	0,086	5,2
DBT	1,69	0,12	6,9
MBT	2,021	0,036	1,6
MPhT	1,617	0,061	3,8

[illegible] % RSD [illegible]

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ɤ ɔɕ ɧữɖỮ

ɖỮɠ ŬɐɞɘɠɗɐɖɖɘŮɖ ɗŭŬ ŭɘŬŭɘŬŭɗŬ ´ ɞɡ ´ Ůɉ ɘɉ Ɣűɖɘ Ů ůữɖɜ Ů ŬɜŬɘɖɣɕɧữɖỮ ɛŮ ữɖ ŭɘŬűɞɉ Ɣ ɧữɘ Ůɞ Ů ŭɘŬɜŬɞɗŮ ůŮ ŭɘŬűɞɉ Ůɘɣɠ ɛɣɉ Ůɠ. Ʉɉ ɏ´ Ůɘ ɜŬ ữɜɜ ɘŮ ɧữɘ ɔɘŬ Ữ ůɛɛŬỮ ´ ɞɡ ɘŬɛɓƔɜɞɜữɘ ´ Ŭɞ Ůɘ ůɖɛ Ŭɜữɘɧ ɉ ɧɘɞ ɘŬɘ ɖ ɘŬữƔůữůɖ ữɞɡ ɔɉ Ŭűɖɖ. ɉ ɜ ɞ ɔɉ Ŭűɖɖɠ ɏɕŮɘ ɖŬɘŬɜ ɤɉ ɖɖŮɘ Ŭɉ ɘŬữƔ ŰɧŮ Ữ MPT ɘŬɘ MBT ´ Ŭɉ ɞɡůɘƔɕɞɡɜ ɕŬɛɖɘɧữɉ ɖ ŮɡŬɘɗɖůɖŬ.

Ʉ´ ɞɘɞɔɕŮữɘɖ ɛɣůɖ ữɛɐ ,ɖ ữɠ´ ɘɐ Ŭ´ ɧɘɘɘɖ ɘŬɘɖ Ů ɘữɞɘɠ ŮɘŬữɧ ữɠ´ ɘɐ Ŭ´ ɧɘɘɘɖ

Ʉɕ ŬɘŬɠ 6.4 ɉ ɜŬ´ Ŭɉ Ŭɓɤ ɔɕɧữɖữɠ ữɤ ɜ ɞɉ ɔŬɜɞɘŬůůɘữɉ ɘɩ ɜ Ůɜɩ ůŮɤ ɜ

ɉ ɜŬɘɨ ữɖɠ	TPT	TBT	DPT	DBT	MPT	MBT
C(ɛ g/L)	3,155	1,920	1,620	1,740	0,760	2,250
SD	0,036	0,099	0,071	0,099	0,031	0,014
RSD%	1,1%	5,2%	4,4%	5,7%	4,1%	0,63%

ȼ Ů ŬɜŬɘɖɣɕɧữɖỮ ɘŬɘɖ ŬɜŬ´ Ŭɉ Ŭɓɤ ɔɕɧữɖỮ Ŭ´ ɞữŮɘɞɨ ɜ ɛɣữ ɞ ữɖɠ´ ɘữɧữɖữɠ ɞ´ ɧữŮɔɘŬ ữɖɜ Ůɘữɛɘɐ ữɞɠɠ ɖŬ ɘƔɓɞɡɛŮɠ´ ɧɣɖɜ ữ %RSD ´ ɞɡ ɘƔɖŮŭɘŬŭɘŬŮɖŬ. ɖɠŬ´ ɞŭŮɘữ ữɛɐ %RSD ɔɘŬ ữ Ů ɗ Ůɞ ůɡɔɘɣɜữɤ ůɖɠ´ ɞɡ ´ ɉ ɞůŭɘɉ ɘɖɘŮɞɉ ɕŮữɘůữ 20% ůɨ ɛűɤ ɜŬ ɛŮ ữɖɜ ɘɨ ɞɡůŬ ɜɛɛɞɗŮɘŬ ɔɘŬ ữɜ ´ ɉ ɞůŭɘɉ ɘɛɧ ữɤ ɜ ůữɘɕŮɤ ɜ.

6.4 Ƀɉ ɗɧữɖỮ (Trueness)

6.4.1 ɉ ɜƔɘữɖůɖ

ŭɘŬ ữɜ ɣɘŮɞɞ ữɖɠ ɞɉ ɗɧữɖữɠ ữɖɠ ɛŮɧŭɞɡ ´ ɉ Ŭɓɛ Ŭữ´ ɞɘɗɖɘŬɜ ´ Ůɉ ƔɛŬỮ ŬɜƔɘữɖůɖɠ. ȼ ŭɘŬŭɘŬŮɖŬ Ŭɡữɐ ´ ɉ Ŭɓɛ Ŭữ´ ɞɘɗɖɘŮɔɘŬ ữɉ ɖŬ Ů ɗ ŮŬ ůɡɔɘŮɜữɉ ɩ ůŮɤ ɜ (ɕŬɛɖɘɧ, ɛŮŬɞ, ɡɣ ɖɘɧ). ȼŬ Ů ɗ ŮŬ ůɡɔɘɣɜữɉ ɤ ůɖɠɐữɜ Ŭ) 0,02 ɛ g/L, ɓ) 0,01 ɛ g/L, ɔ) 0,004 ɛ g/L, ŭ) 0,002 ɛ g/L

ȼ Ů ɘữɞɘɠ ŮɘŬữɧ ŬɜƔɘữɖůɖ ɡ´ ɞɘɞɔɕŮữɘɓƔůŮɘữɞ ´ Ŭɉ ŬɘƔữɤ ữ ´ ɞɡ:

$$\%R= [(C_{Ůɛɓ}/C_{Ŭɓɜ} + ɖɔC)] \times 100$$

ɏ´ ɞɡ CŮɛɓ ɖ ůɡɔɘɣɜữɉ ɤ ůɖ ữɞɡ Ůɛɓɞɘŭůɛɣɜɞɡ ŭŮɓɛŬữɞɠ

CŬɓɜ ɖ ůɡɔɘɣɜữɉ ɤ ůɖ ữɞɡ Ŭɓɜɩ ůữɞɡ ŭŮɓɛŬữɞɠ

ɖɔC ɖ ɔɜɤ ů ữɐ ɛữɓɞɘɐ ɛữƔ ữɖɜ ´ ɉ ɞůɗɐɘɖ ɔɜɤ ůữɠ ůɡɔɘɣɜữɉ ɤ ůɖɠ ŬɜŬɘɨ ữɖ.

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.5 : Εμβολιασμός με 0,01 μg/L

ȷ ɜǓǝǂ Ǘǭǥ	Ǻɛ bǓǔǹ ǝɞȷ ǥǘɐǥ	Ǻɛ bǓǔǹ ǥ´ ɞbƳǭ ɞǥ	Ɇǥɔǝɚɜǘȷ ɤ ůǭ (ɛ g/L)	ȷ ɜƳǝǗǭůǭ Ů ɘ Ǘɞǥ ǕǝǓǗǹ
Ǻɛ bɞǝǝǙůɛ ǹǥ 1 (0,01 ɛ g/L)	0,1053	0,0065	0,006	59,09
Ʉȷ ǹǗǥ´ ɞ 1 (0,01 ɛ g/L)	0,1782	0,0139		
Ǻɛ bɞǝǝǙůɛ ǹǥ 2 (0,01 ɛ g/L)	0,1219	0,0083	0,007	73,70
Ʉȷ ǹǗǥ´ ɞ 2 (0,01 ɛ g/L)	0,1654	0,0129		
Ǻɛ bɞǝǝǙůɛ ǹǥ 3 (0,01 ɛ g/L)	0,1499	0,0116	0,009	86,00
Ʉȷ ǹǗǥ´ ɞ 3 (0,01 ɛ g/L)	0,1743	0,0145		
RSD Ǻʑ ǭƁȘǂ Ɇʑ ƂǞ : 18,0%		**ʑ ɏůǭ ȷ ɜƳǝǗǭůǭ** : 73%		

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…6 : Εμβολιασμός με 0,04 μg/L

ȷ ɜŬəɨ Ŭɋɠ	Ǽɛ bŬŭŋ əɞɟ ɡŭɐɠ	Ǽɛ bŬŭŋ ɡ´ ɞbƳɖɟ ɞɡ	Ɇɡɔəɏɜ Ŭɉ ɤ ůɖ (ɛ g/L)	ȷ ɜƳəŬɖůɖ Ů ɘ Ŭɞɠ ŮbŬŬŋ
Ǽɛ bɞəŴůɛ ŋɠ 1 (0,004 ɛ g/L)	0,0713	0,0057	0,003	65,35
Ʉɟ ŋŬɡ´ ɞ 1 (0,004 ɛ g/L)	0,1091	0,0096		
Ǽɛ bɞəŴůɛ ŋɠ 2 (0,004 ɛ g/L)	0,0859	0,0073	0,003	81,27
Ʉɟ ŋŬɡ´ ɞ 2 (0,004 ɛ g/L)	0,1057	0,0092		
Ǽɛ bɞəŴůɛ ŋɠ 3 (0,004 ɛ g/L)	0,0846	0,0065	0,003	79,44
Ʉɟ ŋŬɡ´ ɞ 3 (0,004 ɛ g/L)	0,1065	0,0072		
RSD Ǽɀ ɗȻʂɟ Ɇɀ ȾɈ : 11,0%		**ɀ ɏůɖ ȷ ɜƳəŬɖůɖ** : 75%		

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ꞪꞷꞵǓɘǓʛ 6.7: ȺɛɓɞɘɇǕůɛɧʛ ɛǕ0,002 ɛg/L

ɉ ɜǓɘɨ Ǘɖʛ	Ⱥɛ ɓǕǔɧ ɘɞɉ ʛǘɐʛ	Ⱥɛ ɓǕǔɧ ʛ´ ɞɓɎɖɉ ɞg	Ɇgɔɘɏɜ Ǘɉ ɤ ůɖ (ɛg/L)	ɉ ɜɎɘǗɖůɖ Ǖ ɘ ǗɞʛǕɘǕǗɧ
ȺɛɓɞɘɇǕůɛɧʛ 1 (0,002 ɛg/L)	0,0514	0,0047	0,002	109,36
Ɜɉ ɧǗʛ´ ɞ 1 (0,002 ɛg/L)	0,0470	0,0031		
ȺɛɓɞɘɇǕůɛɧʛ 2 (0,002 ɛg/L)	0,0480	0,0029	0,002	86,64
Ɜɉ ɧǗʛ´ ɞ 2 (0,002 ɛg/L)	0,0554	0,0044		
ȺɛɓɞɘɇǕůɛɧʛ 3 (0,002 ɛg/L)	0,0523	0,0041	0,002	103,77
Ɜɉ ɧǗʛ´ ɞ 3 (0,002 ɛg/L)	0,0504	0,0031		
RSD Ⱥɀ ɖɃȿɉ Ɇɀ ɃɈ : 11,0%		**ɀ ɏůɖ ɉ ɜɎɘǗɖůɖ** : 100%		

ȼ ǓɜɎɘǗɖůɖ Ǖ ɞǗǕɘǕɑ ɛɏǗɉ ɞ ǗɖʛɞɉɖɧǗɖǕǗʛ. ǘɘǓ ɜǓ ǕɞǓɘ ɘɘǓɞ´ ɞɘɖǗɘɐ ɖ ǓɜɎɘǗɖůɖ ůǕ ɛɘǓ ɛɏɖɞǔɞ ɖǓ´ ɉ ɏ´ Ǖɘ ɜǓ ɓɉ ɖůɘǕǗǓɛǕǗǓɨ 80-120%. ɉ ´ ɞ Ǘɞgʛ´ ɞǓɘǕʛ 6.5, 6.6, 6.7 ´ Ǔɉ ǓǗɖɉ ǕɖǗǓɘ ɧǗɘ ɞɘ ǓɜǓɘǗɐůǕɞʛ ǕɞǓɘ Ǘ ɧ 73-100% Ɏɉ Ǔ ɘǓɘ ůɞǕǗɘɎ Ǖɞ Ǘɧʛ Ǘɤ ɜ Ǘ ɞǔǕɘǗ ɜ ɞɉ ɑɤ ɜ.Ɇgɛ´ Ǖɉ ǓɞɞgɛǕɧǗɘɖ ɛɏɖɞǔɞʛ ǕɞǓɘǓɘɉ ɕɐʛ.

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ƒ εŮďήŭĉϐ Ůεϐϭəǂůŭďəŭǁ 100 εL ŬǁήŢ ϽŬǁϭϐ əŬůůďŮŢ ϭϐ ůϱϽəǂϯŲ ɤůďʃ 1 mg/L ůŮ 500 mL ϱ´ Ůŗ əǂďŬŢ ϭϐ ɨ ŭŬŭϭʃ əŬəŬϭϭϐďϭďďəŮď ŭϭŬŭϭŬůďŬ ´ ϭϐ ´ Ůŗ ϧŢ ǂŭŬŬə ůŭϭ ´ ȷ ɤ Ŭήəϭəə ŭďʃ εŮďήŭĉϐ.ƟŬŢ ŬŭďŢ ɐďďəŮ ήŭə ϱ´ ǂŢ ϭŭə 20% ŬǁǂəŬďůď ŬǁήŢ ϽŬǁϭϐ əŬůůďŮŢ ϭϐ. ȾϱϯŮ ι ʃď εϯďϭŭϭʃ ŭŭǁ ŮǁŬəŬ ήəϱŬŬ ŮəəŮəŭəɐ.

6.6 ȥ ϯŬŢ ďůď ŭŮϭεǂŭɤ ϯ

ƟŢ ŬϽεŬŭǁ´ ϭɐďďəŬǁ εŮŢ ɐůŮϯ ůŮŭŭϭεŬŬŬ Ŭ´ ϭϐəɐŭɤ ϯ ŭɤ ϯ ϱŭŢ ϭďəŮŢ ϧι ϯ Ůŗ ϽϭůŬŬůɤ ϯ ŭďʃ ϙɅȼ ůŮŭϯǂŭϭŢ Ŭϯďůǂ ŭϭϐ ȷ ϧŬϭϐ ůɨ εŭɤ ϯŬεŮŭ ´ ȷ ɤ Ŭήəϭəə ŭďʃ εŮďήŭĉϐ εŮŭď ŭϭŬŭϭŢ ǂ ήŭə ď Ů ŬǁŬŭϭŬəϱŭǁ´ ϭďůď ´ ȷ ŬϽεŬŭǁ´ ϭɐďďəŮůŮ 1 ml Ůǁǂϯϭ ´ ȷ ϭəŮϭϯϭϐ ϯŬ Ŭǁϭϯϱďϭɨ ϯ ´ ϭəɨ ϭŬεďəϯʃ ůϱϽəŮǁŢ ι ůŮϱ ŭɤ ϯ ϭŢ ϽŬǁϭəŬůůϧŢ ϧι ϯ Ůǁι ůŭɤ ϯ. ʔŬ ůďεŮɤ ďŭήŭϯϽϭŮŭϧŢ ďɤ ůď ŭϭ ŮεϐŬŭϭɨ əϭŢ ϱŭɐʃ ϽϧŬ ϯŬ Ŭ´ ϭŭŮϱϭďŭŭ ďŮŭəή ůŭǂəεŬ əήϽɤ ŬǁήŢ ϽŬǁϭϐ əŬůůďŮŢ ϭϐ. ȼŬ Ŭ´ ϭŭŭϯůεŬŬ´ ŬŢ ŬŭďŮǁŬəůŭϯ ´ ϭŬəŬ 6.8

ƟϭŬəŬʃ 6.8: ȥ ϯŬŢ ďůď ϙŮϭεǂŭɤ ϯ Ŭ´ ή ϯďůǂ ŭϭϐ ȷ ϧŬϭϐ

ȷ ʔȷ ʂɈɇȼɆ	C (ppt ɖ pg/mL)
ȽɤϱŢ 9/14	0,20
ŧəŬŢ ďŬ 10	0,14
ʂɐεϯϭʃ 10	0,17
ȾϯŢ ϧϭʃ 11	0,31
ȾǂεϭŢ	2,91
ƟǂŢ ϭʃ	1,13
ȥ ɨ əϭϯϭʃ	0,34
ȥ ɐəϭʃ	0,56
ȾϯŢ ϧϭʃ 10	1,04
ʂɐεϯϭʃ 09	1,62
ȽǂŢ ´ Ŭďϭʃ 11/14	0,89
ȽɤϱŢ 23/10	0,34
ȥ ɐəϭʃ 11/14	0,58

Ⱦɨ εŭɤ ϯŬεŮŬ ϯϭεϭďŮŭǂ ´ əŬŭϧŬ, Ŭ´ ϭŭŮŭϯʃ ŮŭŬϭəůϱϽŮŢ ι ůŮʃ Ŭ´ ή 3 ppt (ɐ 3 pg/mL) əŬə əǂŭɤ . ȷ ´ ôήŭϽϭŮŬəŭŬŮŗ ή Ŭ´ ή ŭϯ ´ ϭŬəŬ Ŭ εŮŢ ϭɨ εŮŬ ŭŮϭεŬŬ ϐŢ ϭəϯŬəεϯůŬ ůŬ Ů ϧŢ Ů ŭǂ ϯϭεϭďŮŭǂ ήŢ ϧŬ.

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