

INTERNATIONAL CAVITATION EROSION TEST

Test Rig Identification Card

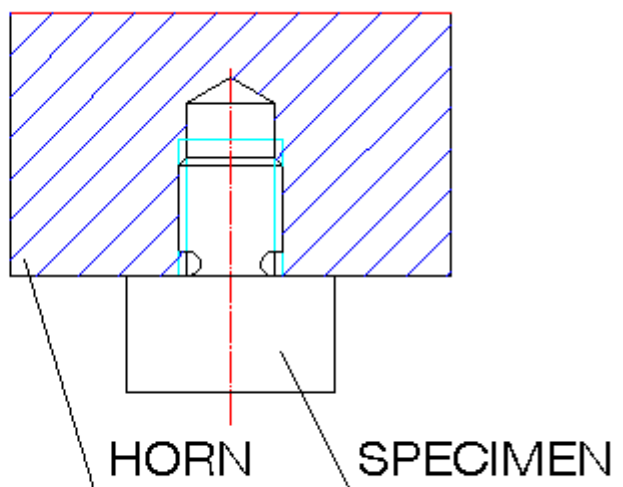
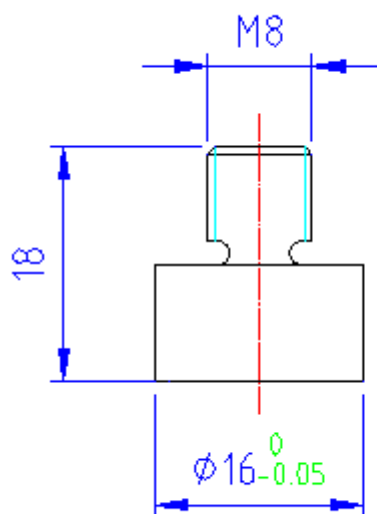
Facility: vibratory rig

Principle of vibration generation:

magnetostriction /~~piezoelectricity~~/

Laboratory: Institute of Water Problems
of the Bulgarian Academy of Sciences

1. Sketch of the sample (counter-sample) with dimensions and showing mounting



2. Basic operational data

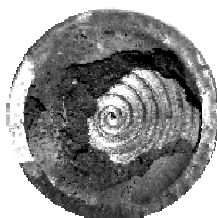
input power: 2000 W
oscillation frequency: 22 ± 0.2 kHz
oscillation amplitude (p-p): 25 ± 2.5 μm
standard temperature: 20 °C
open/~~pressurised~~ vessel
sample submergence depth (open vessel): 4 ± 1 mm
vessel diameter: 90 mm height: 140 mm
sample area subjected to damage: 201.06 mm²
other data: water depth in the vessel: 90 mm;
automatic control of oscillation amplitude;
automatic control of water temperature

designer:

Institute of Water Problems of the Bulgarian Academy of Sciences

manufacturer:

Industrial Electronics Works, Gabrovo, Bulgaria



INTERNATIONAL CAVITATION EROSION TEST

Laboratory Results Summarisation

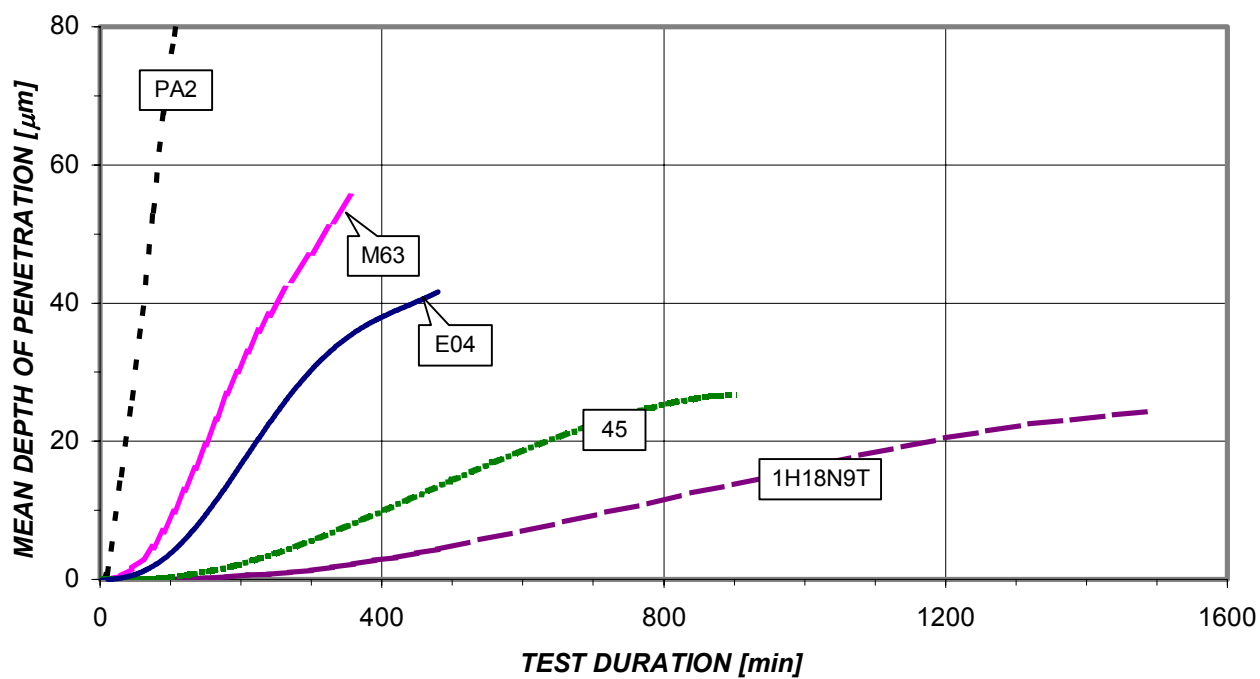
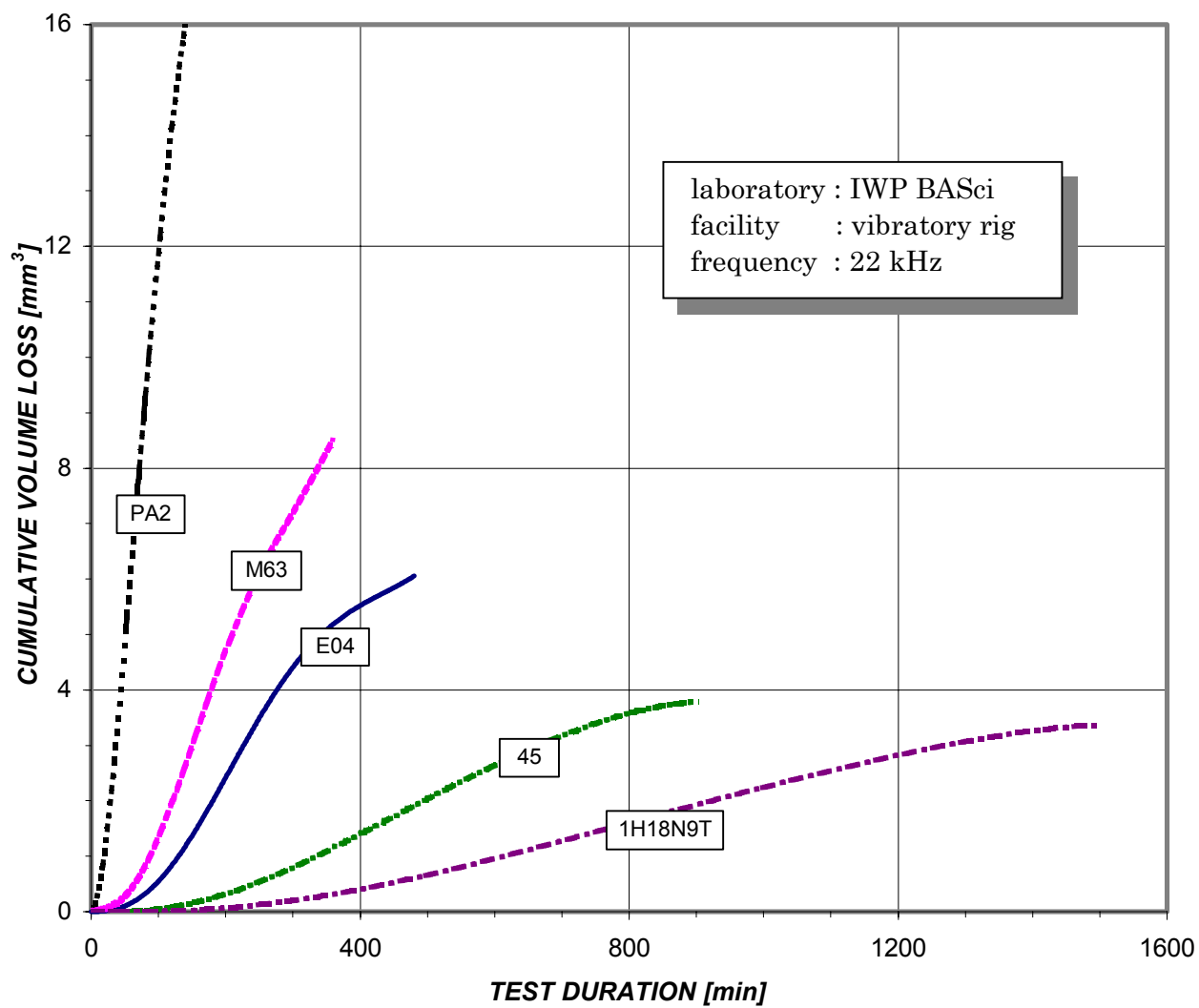
Laboratory: **INSTITUTE OF WATER PROBLEMS
OF THE BULGARIAN ACADEMY OF SCIENCES**
SOFIA, Bulgaria

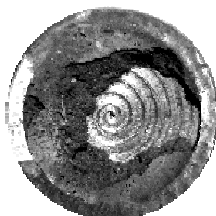
Facility: **VIBRATORY RIG**

oscillation frequency: 22 ± 0.2 kHz *sample submergence:* 3 mm
amplitude: 25 ± 2.5 μ m *impinged area:* 201.06 mm²

working liquid: distilled water, 20 °C

material	Test duration	Volume loss	Eroded area	Mean&Max Depth of Penetration		Incubation period		MDPR	
						$\tau_{0.2}$	τ_{inc}	max	ultimate
	min	mm ³	mm ²	μ m	μ m	min	min	μ m/min	
PA2	240	22.15	158.6	139.70	-	10	16.91	0.920	0.320
M63	240	5.81	151.7	38.30	-	20	64.35	0.231	0.140
E04	240	3.34	145.4	22.97	-	45	92.35	0.153	0.181
45	240	0.48	141.4	3.37	-	90	182.00	0.045	0.033
1H18N9T	240	0.11	138.7	0.78	-	150	-	0.005	0.005
M63	360	8.50	151.7	55.99	-	20	64.35	0.231	0.140
E04	360	5.15	145.4	35.41	-	45	92.35	0.153	0.075
45	360	1.17	141.4	8.29	-	90	182.00	0.045	0.043
1H18N9T	360	0.31	138.7	2.21	-	150	311.00	0.016	0.016
E04	480	6.03	145.4	41.50	-	45	92.35	0.153	<0.035
45	480	1.91	141.4	13.50	-	90	182.00	0.045	0.045
1H18N9T	480	0.61	138.7	4.39	-	150	311.00	0.020	0.020
45	900	3.79	141.4	26.76	-	90	182.00	0.045	<0.002
1H18N9T	900	1.91	138.7	13.76	-	150	311.00	0.021	0.021
1H18N9T	1500	3.38	138.7	24.37	-	150	311.00	0.024	<0.009





INTERNATIONAL CAVITATION EROSION TEST

Laboratory Results Summarisation

Laboratory: **INSTITUTE OF WATER PROBLEMS
OF THE BULGARIAN ACADEMY OF SCIENCES**
SOFIA, Bulgaria

Facility: **VIBRATORY RIG**

oscillation frequency: 22 ± 0.2 kHz *sample submergence:* 3 mm
amplitude: 25 ± 2.5 μ m *impinged area:* 201.06 mm²
working liquid: distilled water, 20 °C

Material: PA2 aluminium alloy

<i>speci- men</i>	<i>test duration</i>	<i>mass loss</i>	<i>volume loss</i>	<i>eroded area</i>	<i>Mean&Max Depth of Penetration</i>		<i>Incubation period</i> $\tau_{0.2}$ τ_{inc}		<i>MDPR_{max}</i>
no.	min	g	mm ³	mm ²	μ m	μ m	min	min	μ m/min
1.	240	0.0587	21.797	156.4	139.37	-	10	15.65	0.92
2.	240	0.0606	22.503	160.7	140.03	-	10	16.96	0.92

Mean values

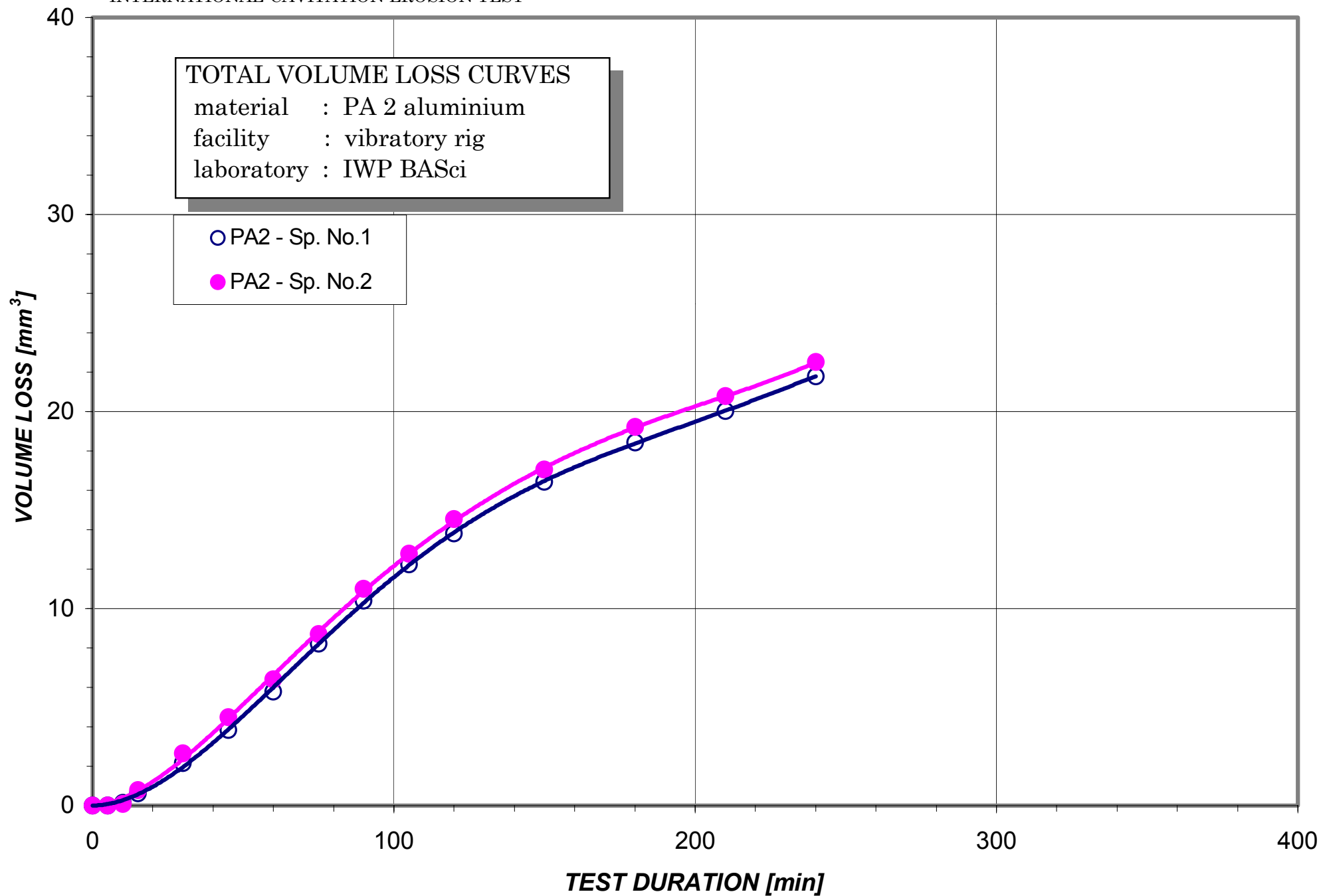
	240	0.0597	22.150	158.6	139.70	-	10	16.91	0.92
--	-----	--------	--------	-------	--------	---	----	-------	------

Enclosure

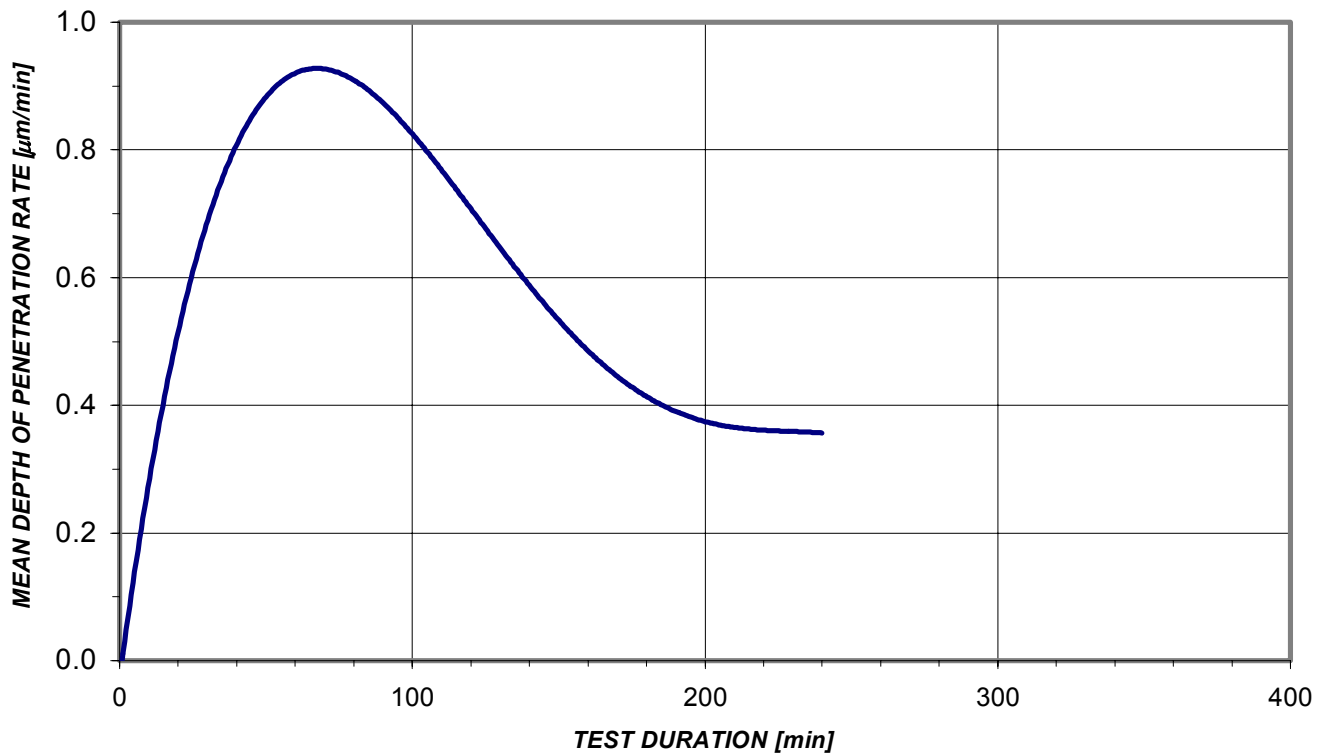
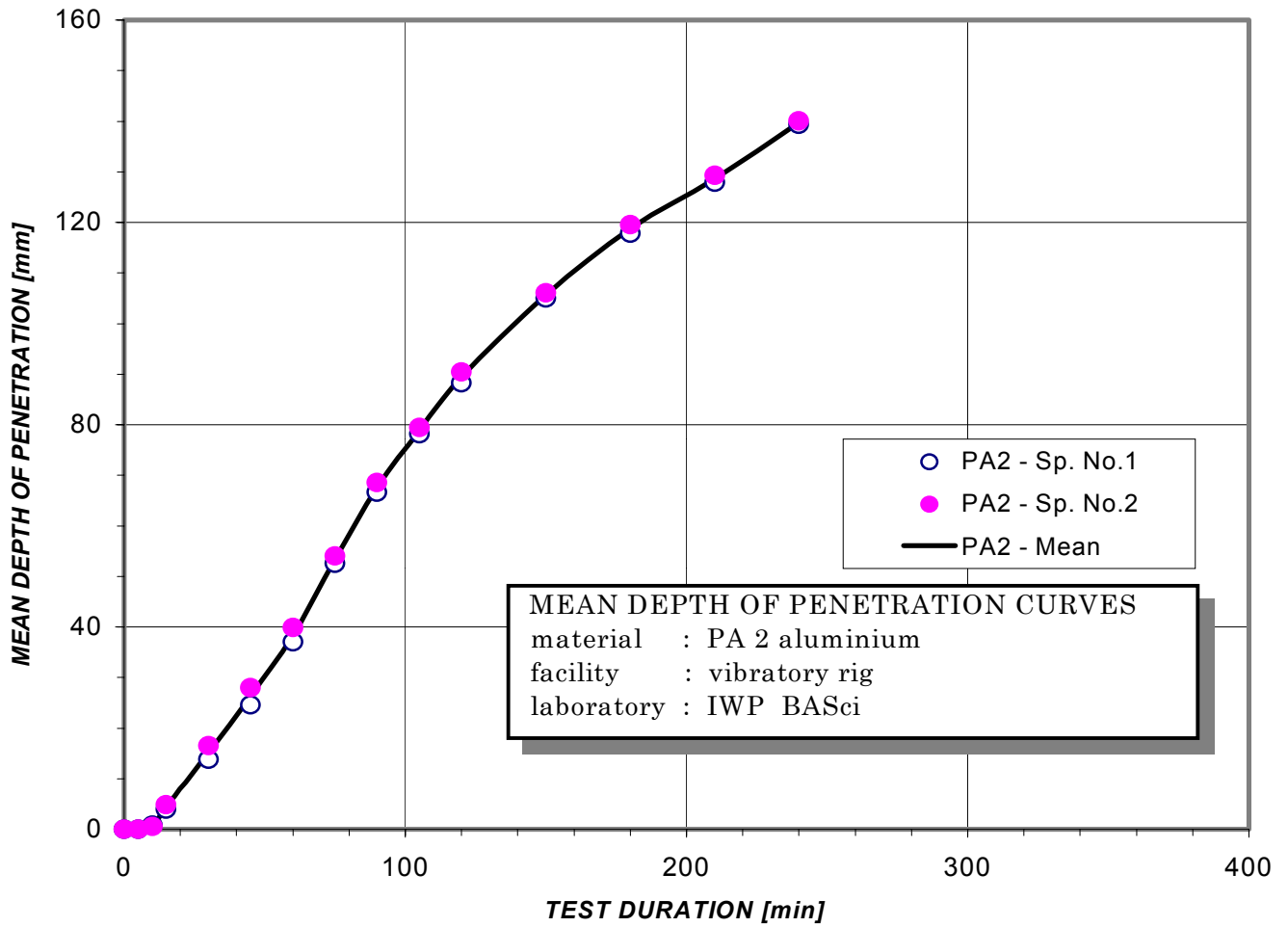
Results of hardness measurement

INTERNATIONAL CAVITATION EROSION TEST

VR 288



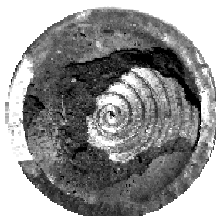
INTERNATIONAL CAVITATION EROSION TEST



Enclosure

Results of Hardness Measurement
(according to Vickers)
Loading Force of 5 kG (HV₅)
Unit : kG/mm²

PA2 aluminium alloy			
Specimen No.	Distance from the sample centre		
	0.0	0,2r	0,5r
1	83.20	84.10	82.90
2	84.80	85.60	83.70
mean values	84.00	84.85	83.30
base material	61,50 ÷ 62,80		



INTERNATIONAL CAVITATION EROSION TEST

Laboratory Results Summarisation

Laboratory: **INSTITUTE OF WATER PROBLEMS
OF THE BULGARIAN ACADEMY OF SCIENCES**
SOFIA, Bulgaria

Facility: **VIBRATORY RIG**

oscillation frequency: 22 ± 0.2 kHz *sample submergence:* 3 mm
amplitude: 25 ± 2.5 μ m *impinged area:* 201.06 mm²
working liquid: distilled water, 20 °C

Material: M63 brass

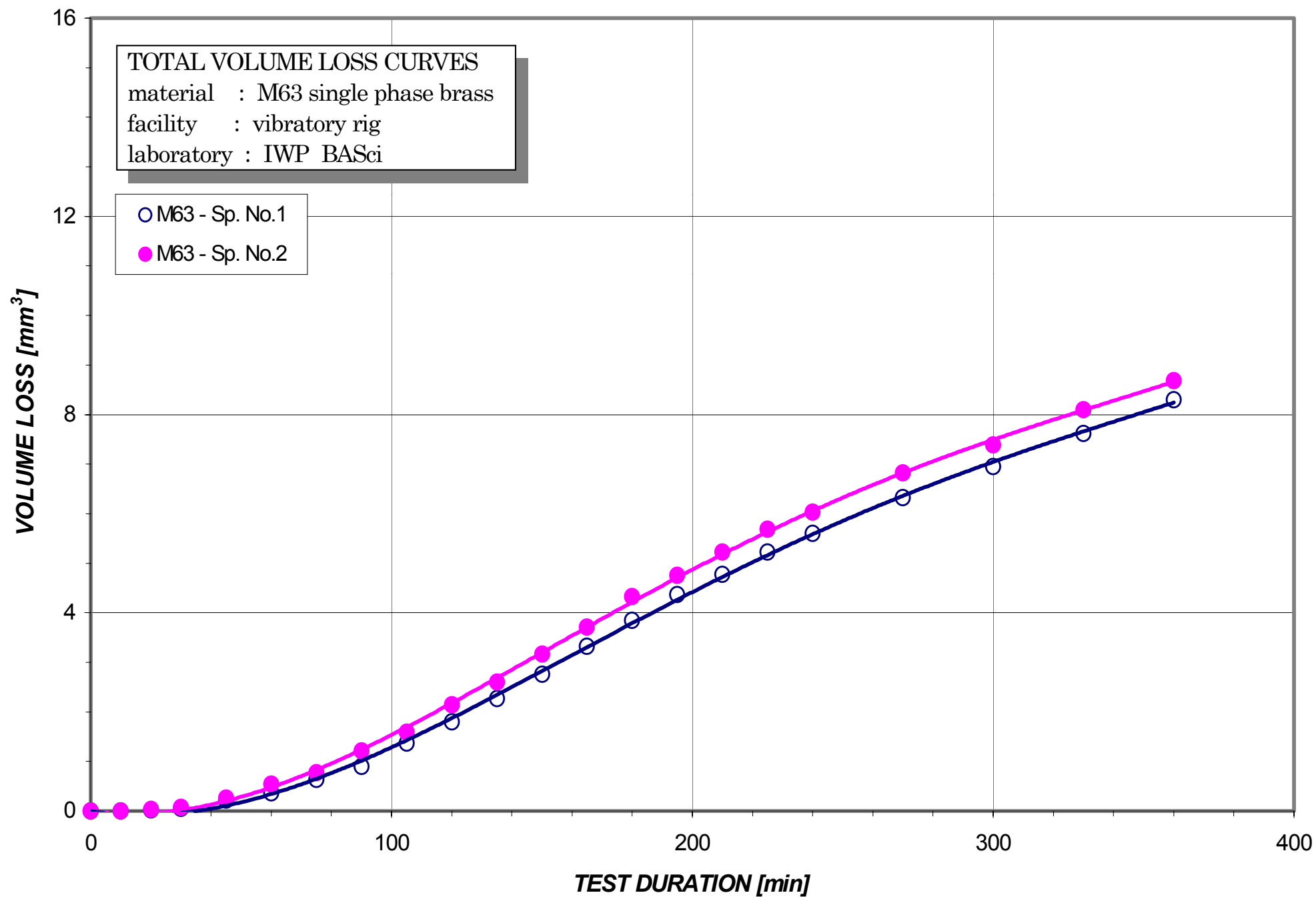
<i>speci- men</i>	<i>test duration</i>	<i>mass loss</i>	<i>volume loss</i>	<i>eroded area</i>	<i>Mean&Max Depth of Penetration</i>		<i>Incubation period</i> $\tau_{0.2}$ τ_{inc}		<i>MDPR_{max}</i>
no.	min	g	mm ³	mm ²	μ m	μ m	min	min	μ m/min
3.	360	0.06995	8.30	148.7	55.80	-	20	66.52	0.230
4.	360	0.07325	8.69	154.7	56.17	-	20	58.02	0.232

Mean values

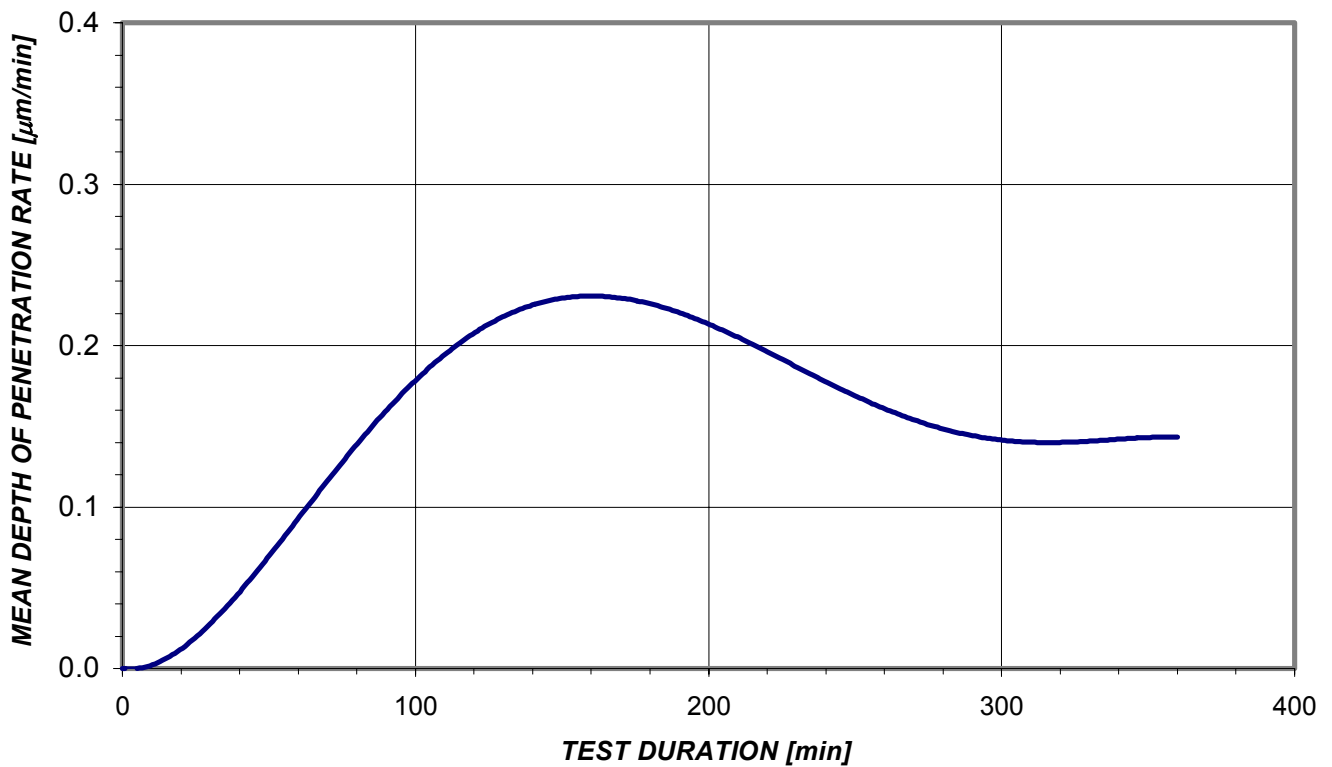
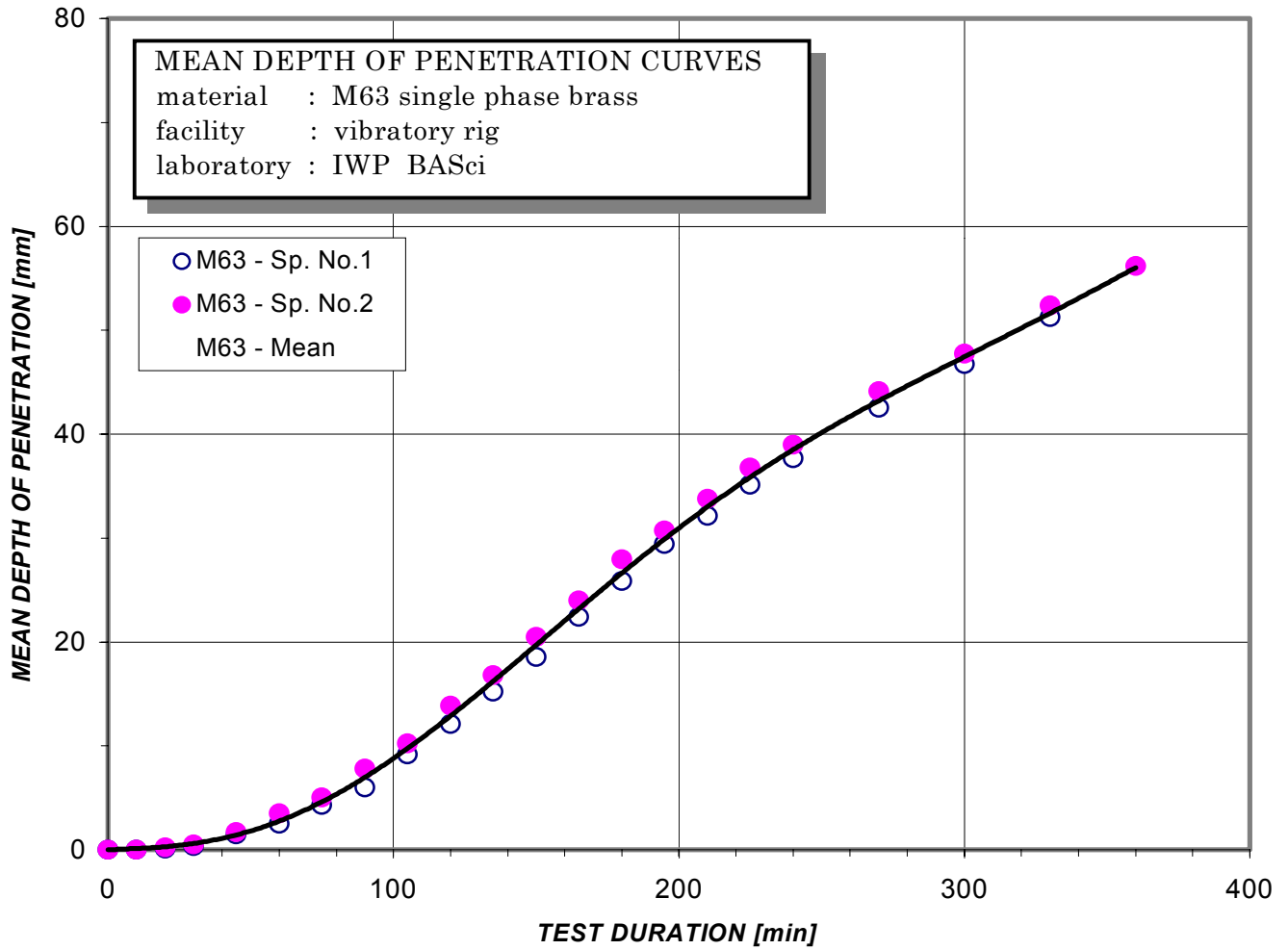
	360	0.0716	8.50	151.7	55.99	-	20	64.35	0.231
--	-----	--------	------	-------	-------	---	----	-------	-------

Enclosure

Results of hardness measurement



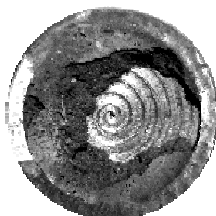
INTERNATIONAL CAVITATION EROSION TEST



Enclosure

Results of Hardness Measurement
(according to Vickers)
Loading Force of 5 kG (HV₅)
Unit : kG/mm²

M63 single phase brass			
<i>Specimen No.</i>	<i>Distance from the sample centre</i>		
	0.0	0,2r	0,5r
1	111.20	114.10	116.30
2	112.90	115.30	114.60
mean values	112.05	114.70	115.45
base material	72,20 ÷ 74,60		



INTERNATIONAL CAVITATION EROSION TEST

Laboratory Results Summarisation

Laboratory: **INSTITUTE OF WATER PROBLEMS
OF THE BULGARIAN ACADEMY OF SCIENCES**
SOFIA, Bulgaria

Facility: **VIBRATORY RIG**

oscillation frequency: 22 ± 0.2 kHz *sample submergence:* 3 mm
amplitude: 25 ± 2.5 μ m *impinged area:* 201.06 mm²
working liquid: distilled water, 20 °C

Material: E04 armco iron

<i>speci- men</i>	<i>test duration</i>	<i>mass loss</i>	<i>volume loss</i>	<i>eroded area</i>	<i>Mean&Max Depth of Penetration</i>		<i>Incubation period</i> $\tau_{0.2}$ τ_{inc}		<i>MDPR_{max}</i>
no.	min	g	mm ³	mm ²	μ m	μ m	min	min	μ m/min
5.	480	0.04605	5.86	144.2	40.67	-	45	92.35	0.153
6.	480	0.04870	6.20	146.5	42.33	-	45	92.35	0.153

Mean values

	480	0.04738	6.03	145.4	41.50	-	45	92.35	0.153
--	-----	---------	------	-------	-------	---	----	-------	-------

Enclosure

Results of hardness measurement

TOTAL VOLUME LOSS CURVES

material : E04 armco iron

facility : vibratory rig

labotory : IWP BASci

○ E04 - Sp. No.1

● E04 - Sp. No.2

VOLUME LOSS [mm³]

TEST DURATION [min]

6

4

2

0

0

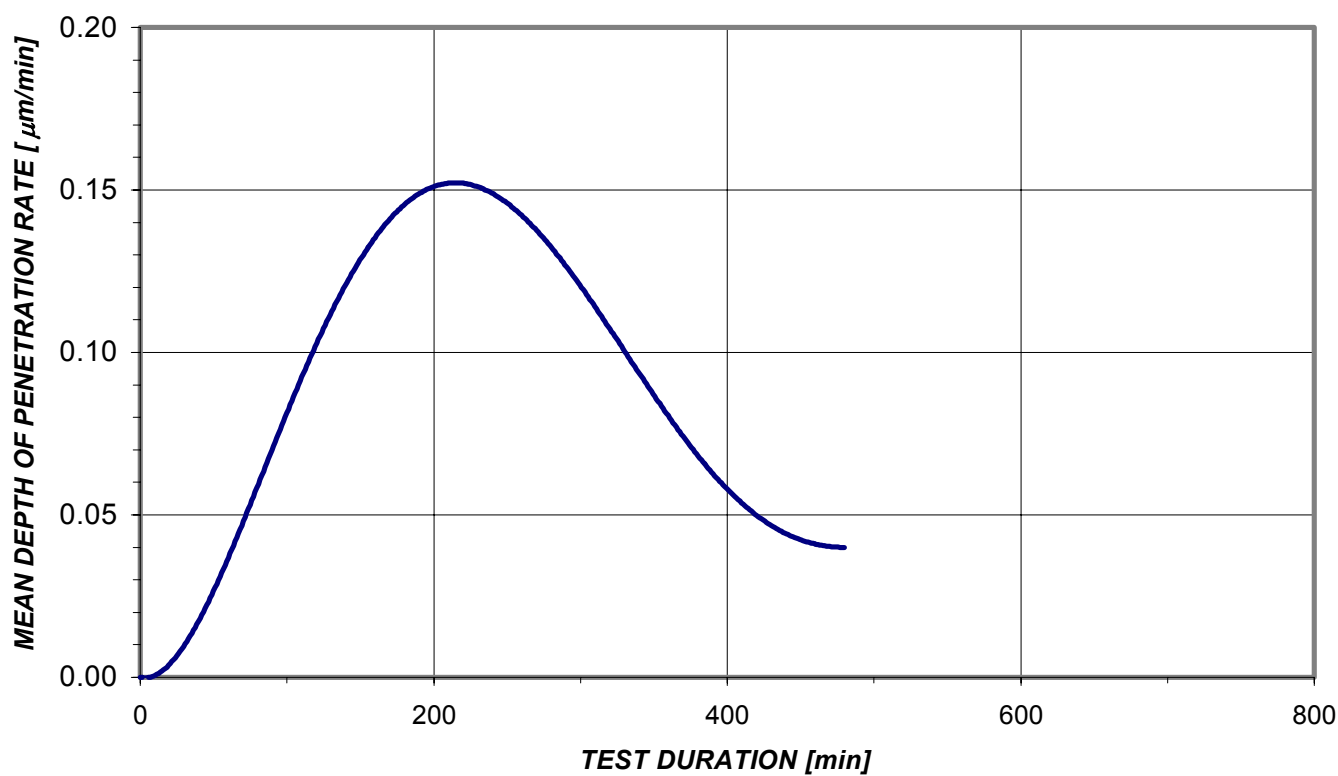
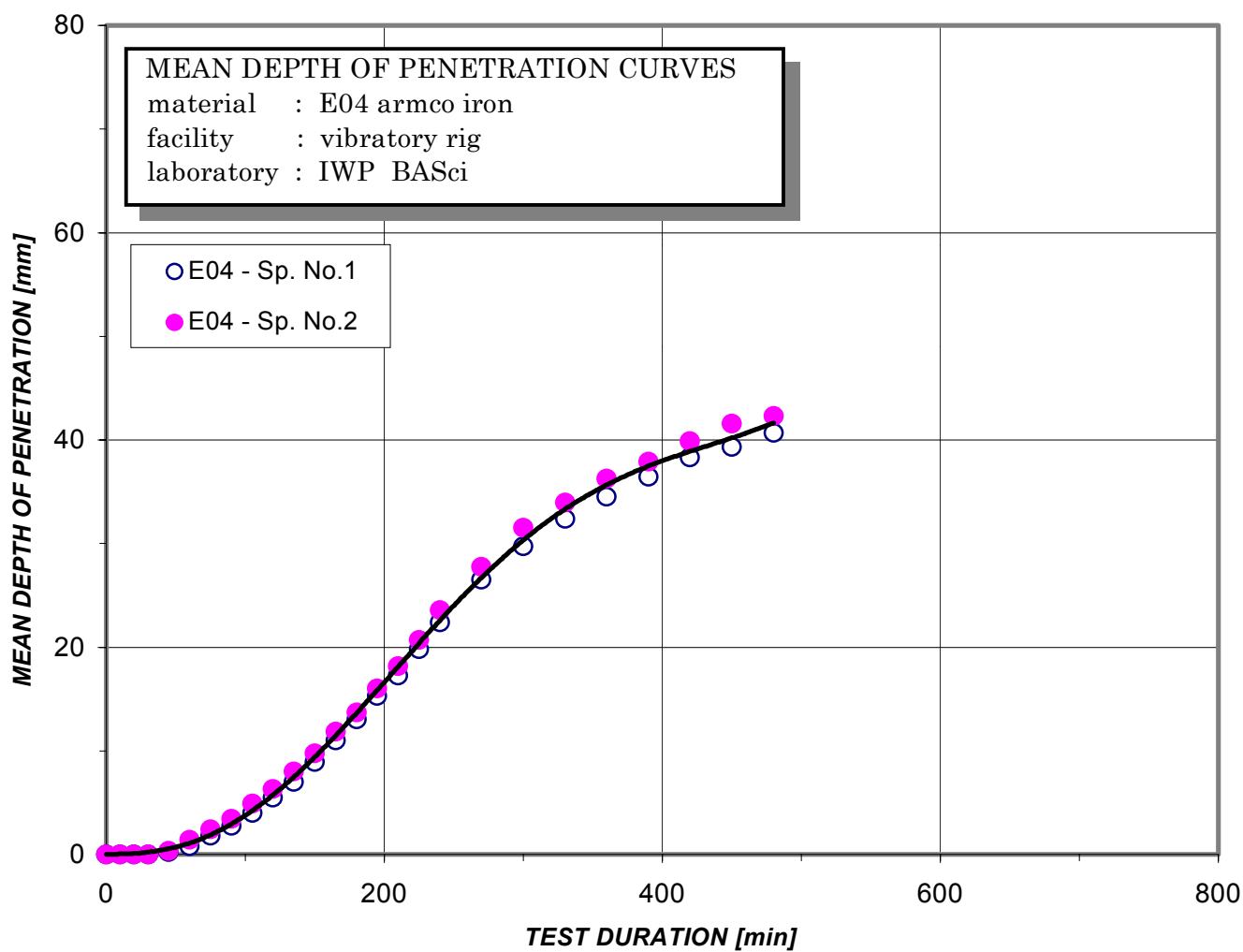
200

400

600

800

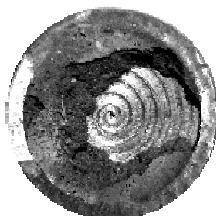
INTERNATIONAL CAVITATION EROSION TEST



Enclosure

Results of Hardness Measurement
(according to Vickers)
Loading Force of 5 kG (HV₅)
Unit : kG/mm²

E04 Armco iron			
Specimen No.	Distance from the sample centre		
	0.0	0,2r	0,5r
1	145.20	148.10	147.30
2	147.10	146.60	149.00
mean values	146.15	147.35	148.15
base material	98,20 ÷ 100,30		



INTERNATIONAL CAVITATION EROSION TEST

Laboratory Results Summarisation

Laboratory: **INSTITUTE OF WATER PROBLEMS
OF THE BULGARIAN ACADEMY OF SCIENCES**
SOFIA, Bulgaria

Facility: **VIBRATORY RIG**

oscillation frequency: 22 ± 0.2 kHz *sample submergence:* 3 mm
amplitude: 25 ± 2.5 μ m *impinged area:* 201.06 mm²
working liquid: distilled water, 20 °C

Material: 45 carbon steel

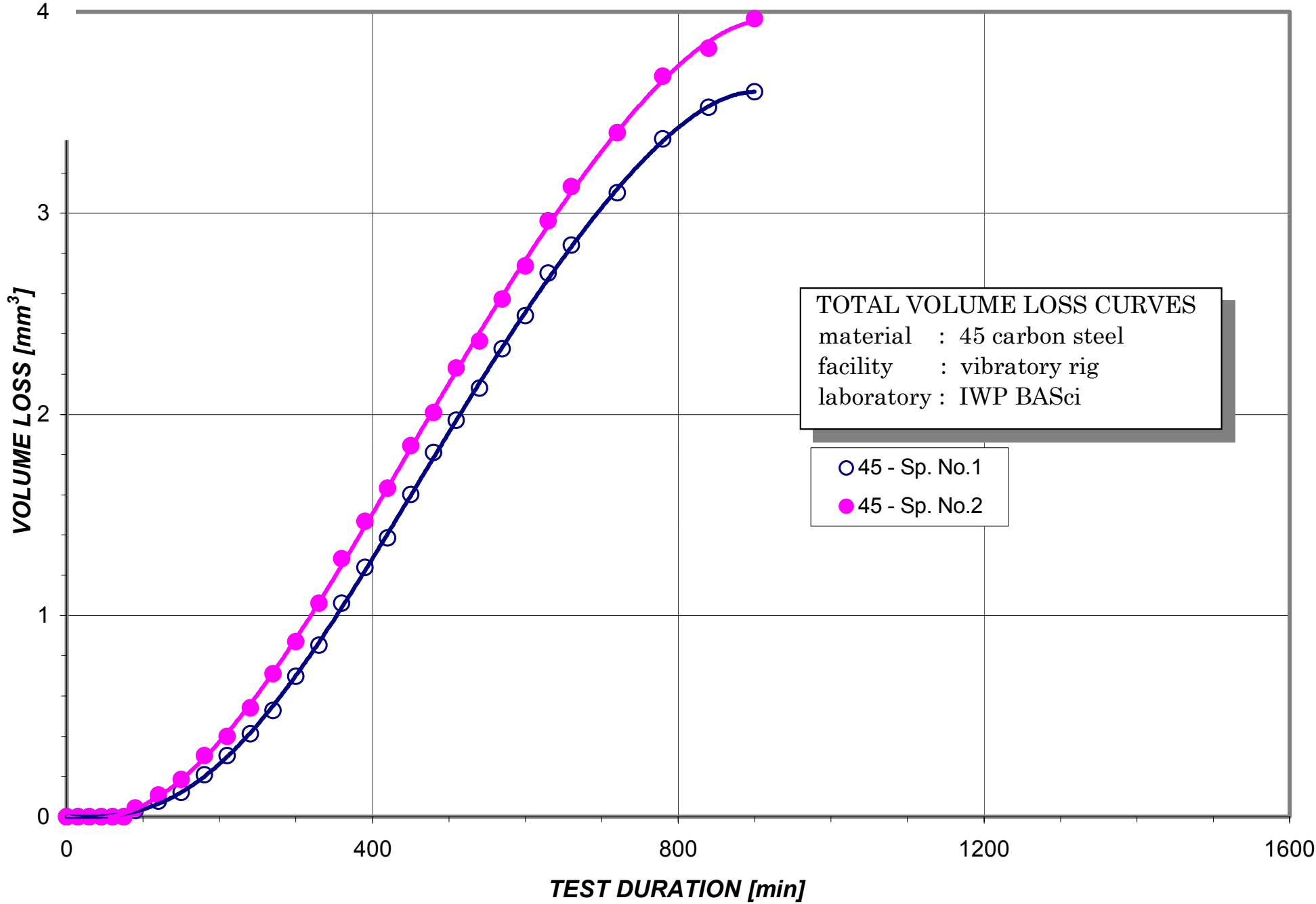
<i>speci- men</i>	<i>test duration</i>	<i>mass loss</i>	<i>volume loss</i>	<i>eroded area</i>	<i>Mean&Max Depth of Penetration</i>		<i>Incubation period</i> $\tau_{0.2}$ τ_{inc}		<i>MDPR_{max}</i>
no.	min	g	mm ³	mm ²	μ m	μ m	min	min	μ m/min
7.	900	0.02835	3.60	140.2	25.70	-	90	197	0.0449
8.	900	0.03120	3.97	142.6	27.81	-	90	168	0.0455

Mean values

	900	0.02978	3.79	141.4	26.76	-	90	182	0.0452
--	-----	---------	------	-------	-------	---	----	-----	--------

Enclosure

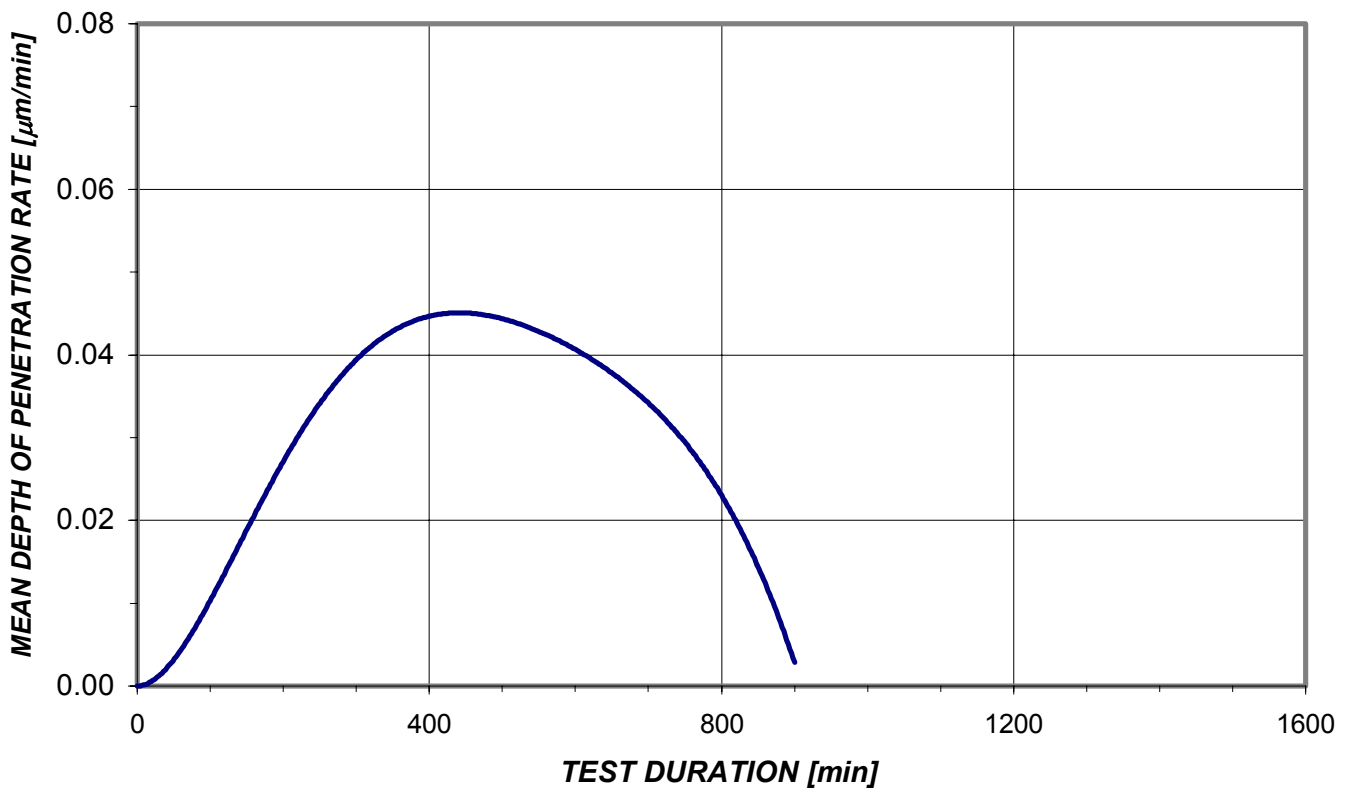
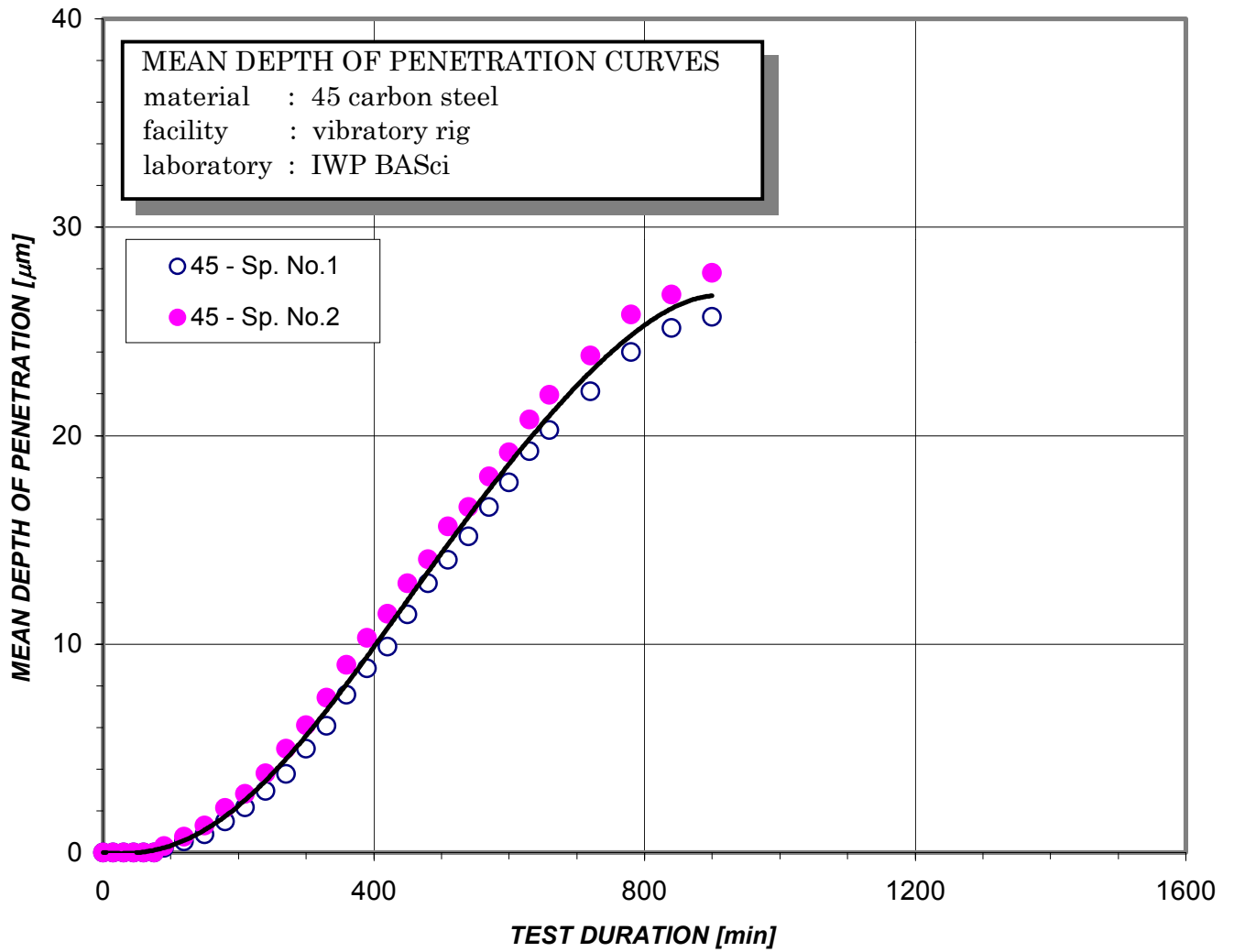
Results of hardness measurement



TOTAL VOLUME LOSS CURVES
material : 45 carbon steel
facility : vibratory rig
laboratory : IWP BASci

○ 45 - Sp. No.1
● 45 - Sp. No.2

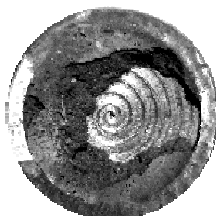
INTERNATIONAL CAVITATION EROSION TEST



Enclosure

Results of Hardness Measurement
(according to Vickers)
Loading Force of 5 kG (HV₅)
Unit : kG/mm²

45 carbon steel			
Specimen No.	Distance from the sample centre		
	0.0	0,2r	0,5r
1	244.10	245.40	246.70
2	245.80	248.70	247.80
mean values	244.95	247.05	247.25
base material	179.6 ÷ 181.9		



INTERNATIONAL CAVITATION EROSION TEST

Laboratory Results Summarisation

Laboratory: **INSTITUTE OF WATER PROBLEMS
OF THE BULGARIAN ACADEMY OF SCIENCES**
SOFIA, Bulgaria

Facility: **VIBRATORY RIG**

oscillation frequency: 22 ± 0.2 kHz *sample submergence:* 3 mm
amplitude: 25 ± 2.5 μ m *impinged area:* 201.06 mm²
working liquid: distilled water, 20 °C

Material: 1H18N9T stainless steel

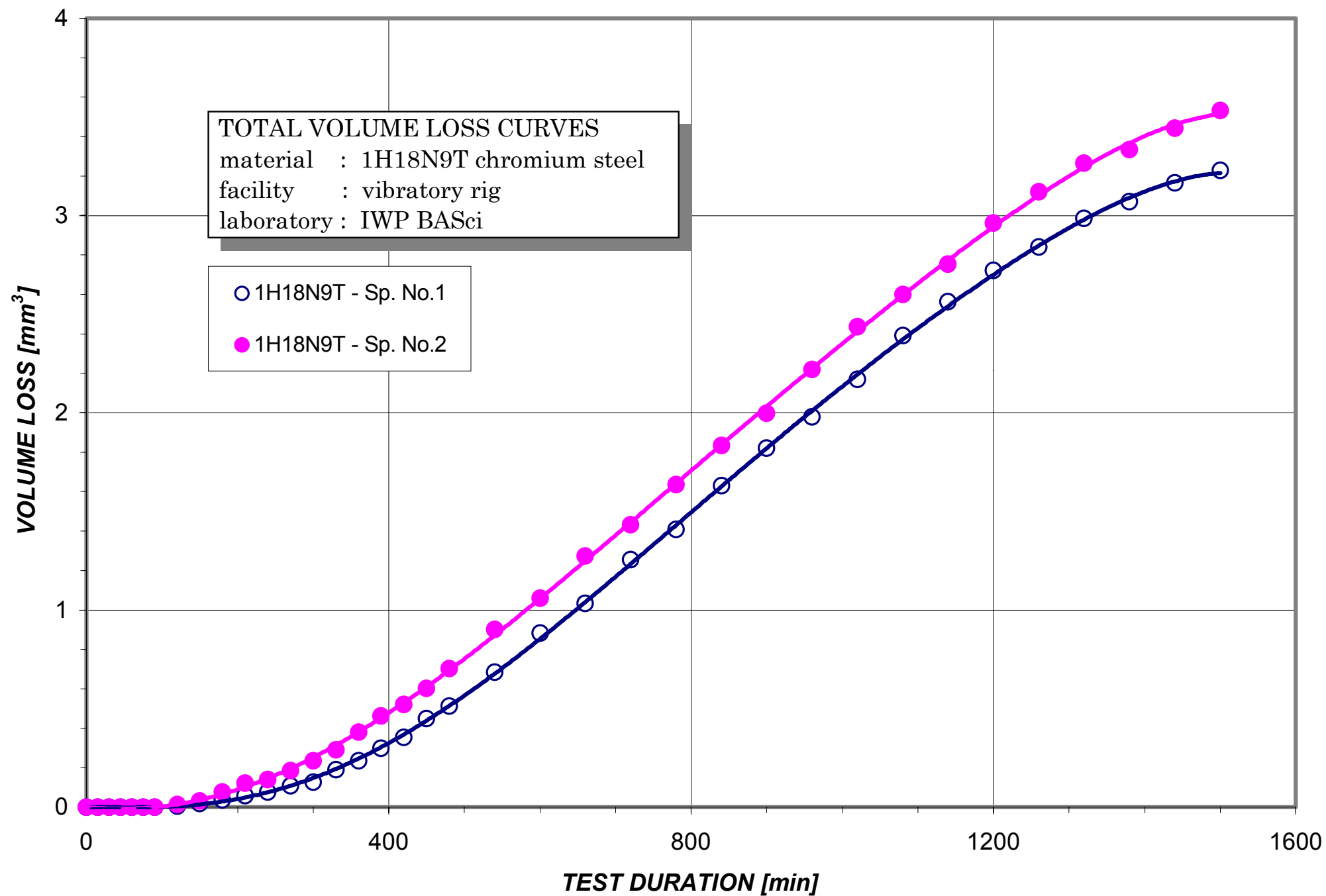
<i>speci- men</i>	<i>test duration</i>	<i>mass loss</i>	<i>volume loss</i>	<i>eroded area</i>	<i>Mean&Max Depth of Penetration</i>		<i>Incubation period</i> $\tau_{0.2}$ τ_{inc}		<i>MDPR_{max}</i>
no.	min	g	mm ³	mm ²	μ m	μ m	min	min	μ m/min
9.	1500	0.02545	3.23	137.6	23.45	-	150	343	0.0238
10.	1500	0.02785	3.53	139.7	25.28	-	150	289	0.0235

Mean values

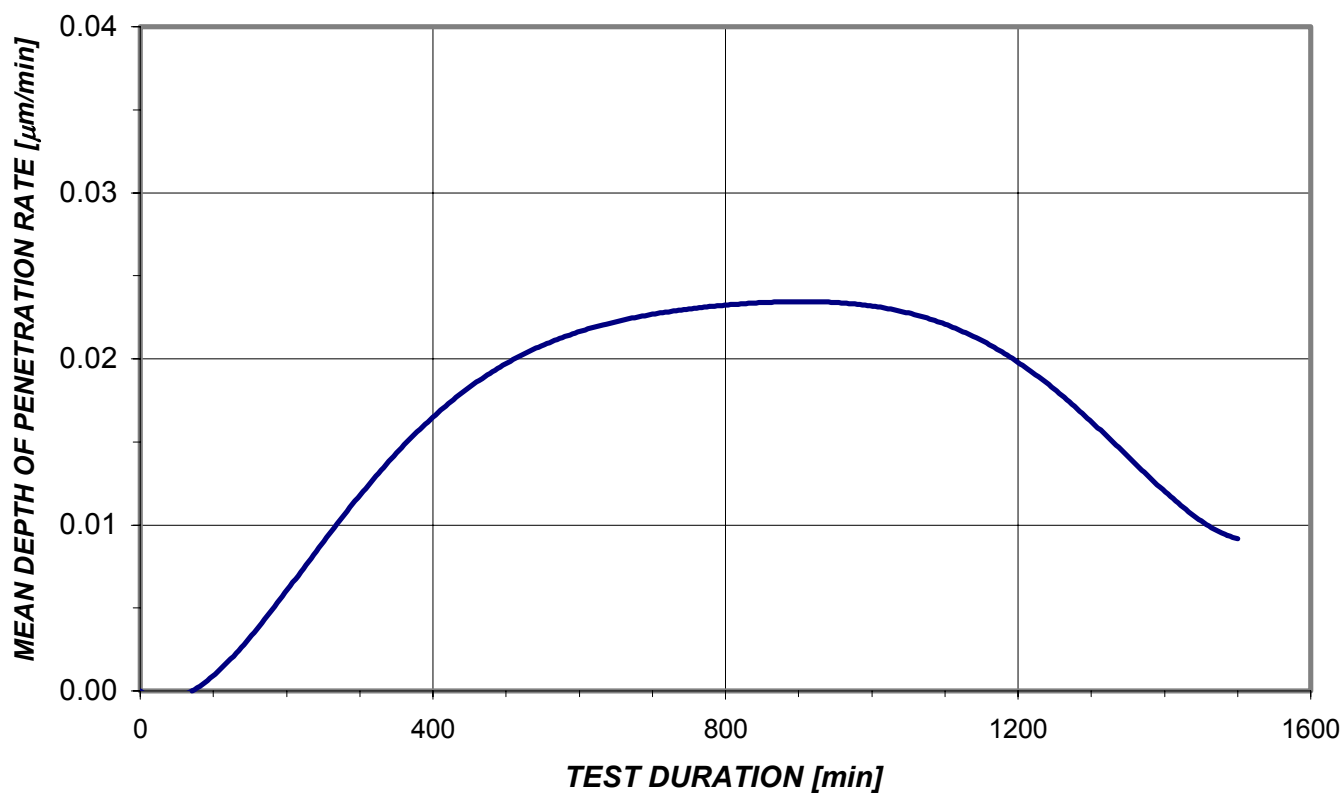
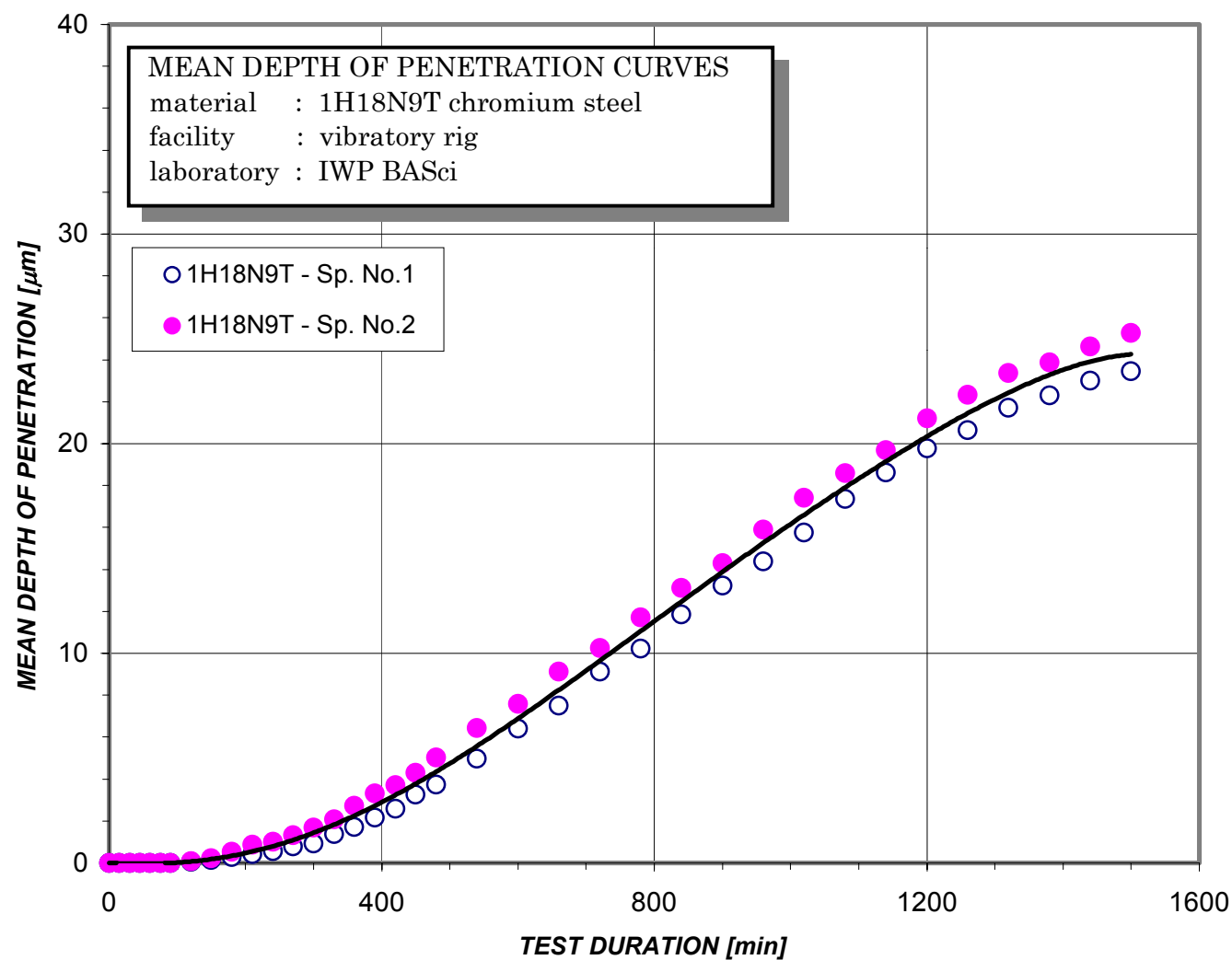
	1500	0.02665	3.38	138.7	24.37	-	150	311	0.0235
--	------	---------	------	-------	-------	---	-----	-----	--------

Enclosure

Results of hardness measurement



INTERNATIONAL CAVITATION EROSION TEST



Enclosure

Results of Hardness Measurement
(according to Vickers)
Loading Force of 5 kG (HV₅)
Unit : kG/mm²

1H18N9T chromium nickel steel			
Specimen No.	Distance from the sample centre		
	0.0	0,2r	0,5r
1	260.30	264.10	263.70
2	262.80	261.40	266.30
mean values	261.55	262.75	265.00
base material	177,50 ÷ 179,80		