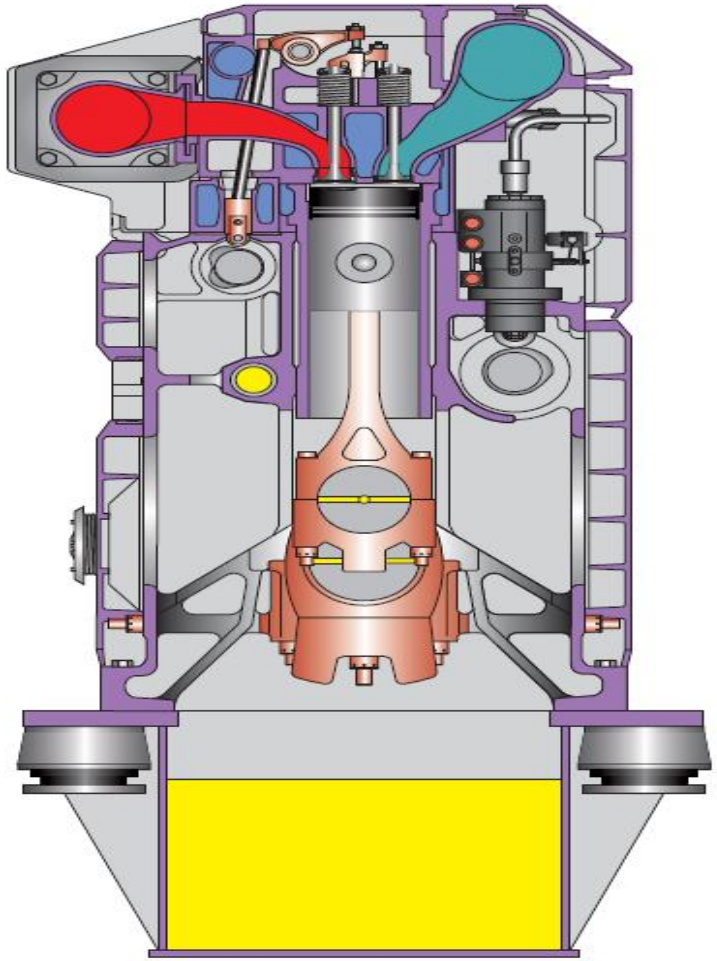
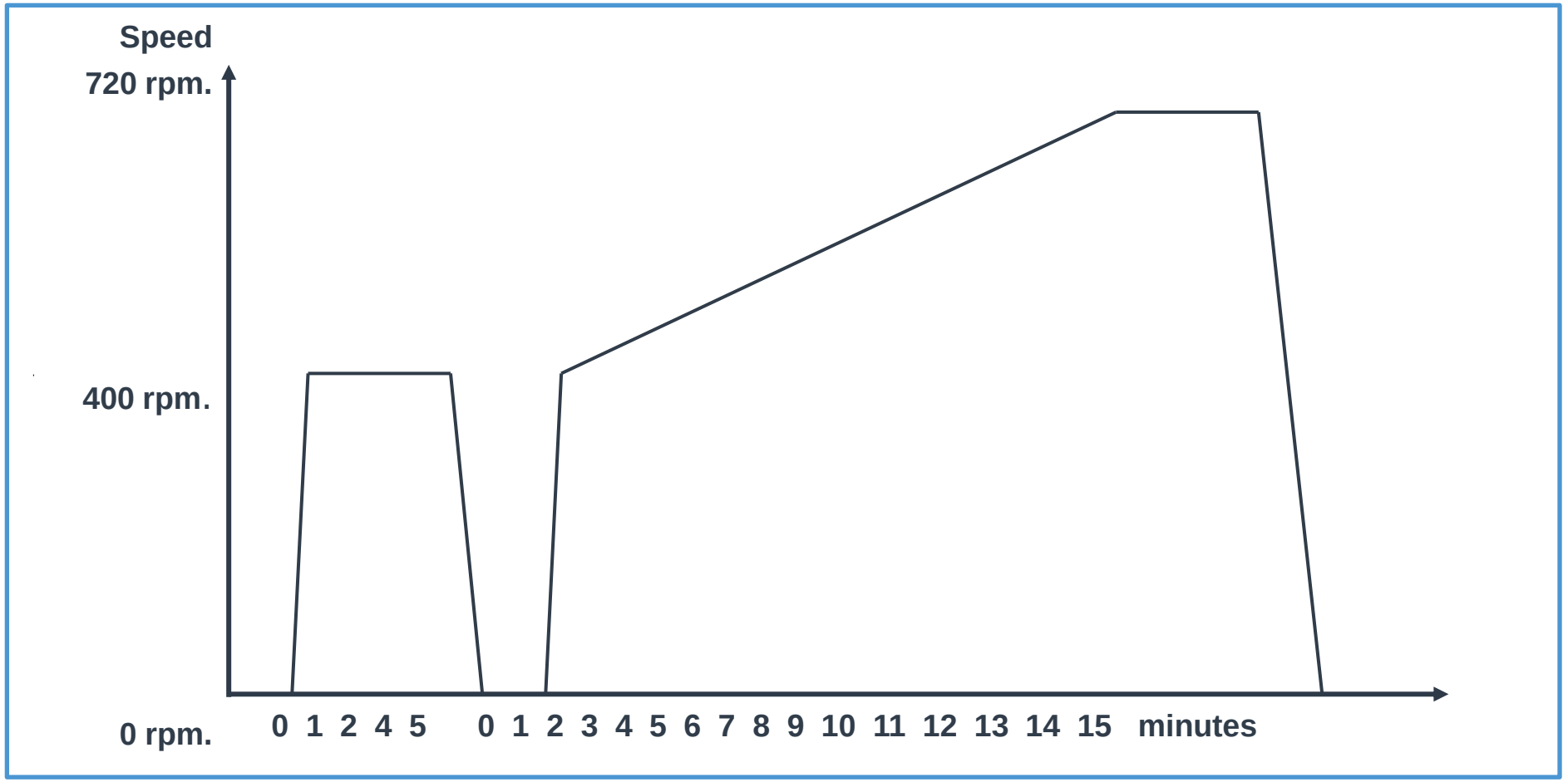
L23/30H & L28/32H Engine performance and Condition

Engine Performance

- What is performance
- Before starting up
- Evaluation of reading
- Performance sheets
- Performance sheets comparison
- Adjustment of Pmax
- Part load/low load operation
- Air density
- Timing influence on NOx and SFOC
- Exhaust temperature



Starting up & feeling over the GenSet
After overhauling

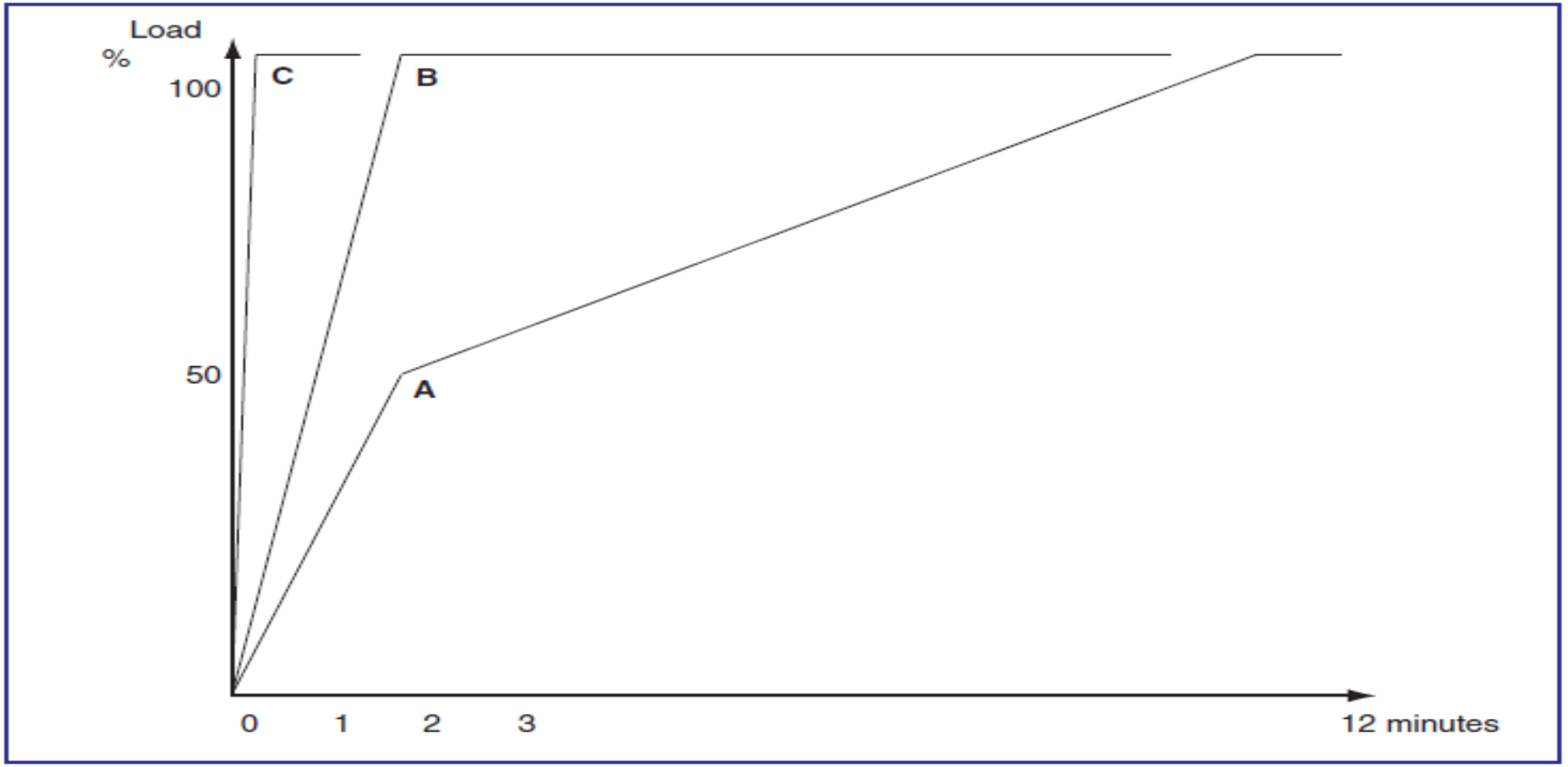


Starting up & feeling over the GenSet
After overhauling

After repair of engine parts, and overhaul of the engine !!

- Start and run the engine for 5 min. At slow speed.
  - Check the engine performance
  - Check the lubricating oil pressure
  - Check the cooling water pressure
  - Check the fuel oil feed pressure
  - Check the lub. Oil pressure to turbocharger
  - Check that the turbocharger is running
  - Check that all cylinders are firing. (Exh. Gas temp.)
  - Check the rotor cap at valve spindle
  - Check for leakage
  - Check for abnormality
  - Stop the engine and open the crank shaft doors
  - Check the crank shaft, connection road bearing and engine lubricating
  - If all is in good order start the engine and run slowly up to rated speed over 15 minutes

Loading up the GenSet
Guidelines



Loading up the GenSet
Guidelines

A:

Normal start without preheated cooling water.

Only on MDO.

B:

Normal start with preheated cooling water.

MDO or HFO.

C:

Stand-by engine. Emergency start,

with preheated cooling water,

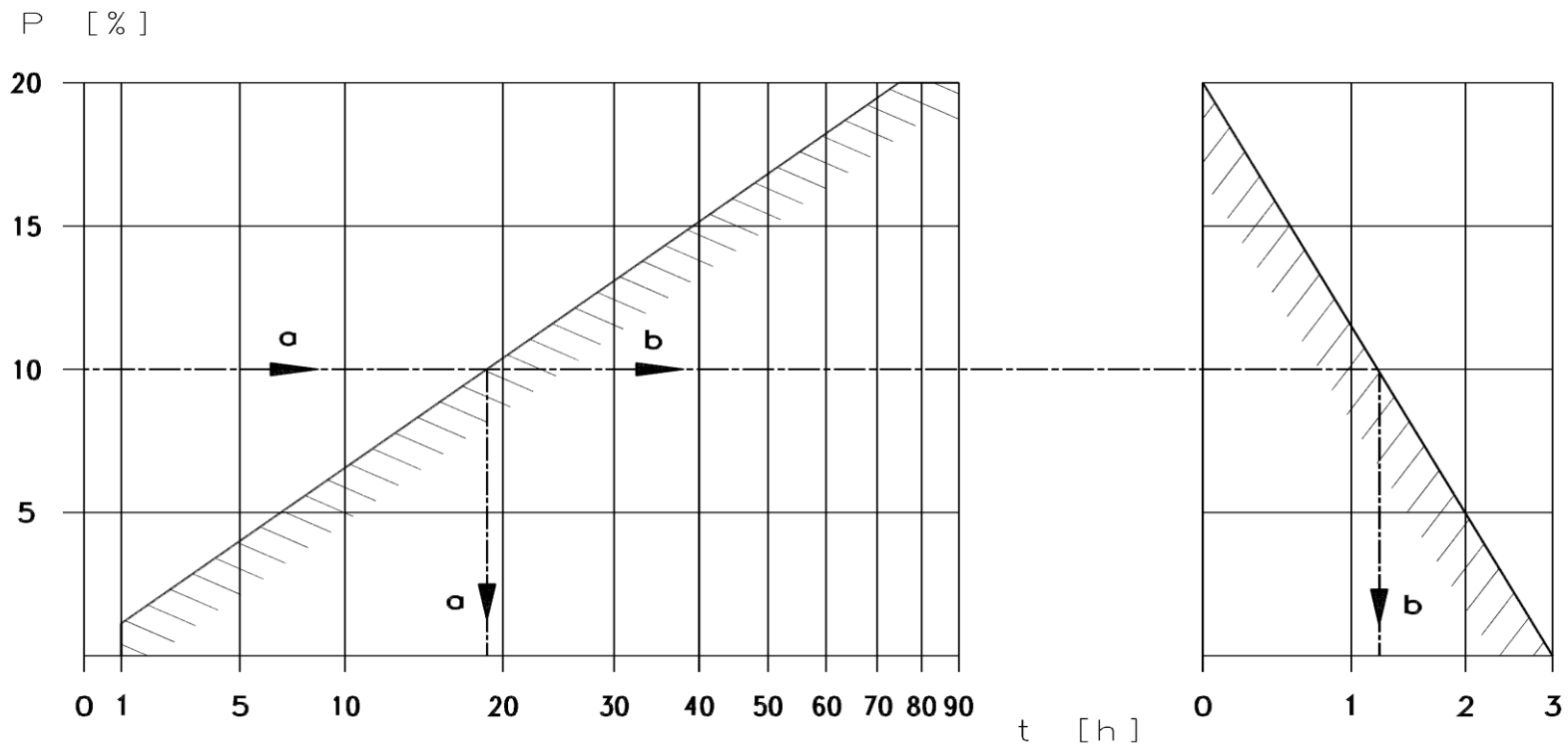
With pre lubricating oil,

MDO or HFO.

Attention:

Common for all start / stop and loading / de loading of engine is to be carried out without any alarms……

Low-Load Operation
16/24 – 21/31 – 27/38 – 23/30 – 28/32 – 32/40



10 % of full load: max. 19 hours of heavy fuel operation
Operate engine approx. 1.2 hours at a minimum of >70 % of the full load
Continual low load at diesel oil load the engine to >70% 2 hours of full load weekly

Low-Load Operation HFO Consequence

Low-Load Operation HFO Consequence

Low-Load Operation HFO Consequence

Low-Load Operation HFO Consequence

Low-Load Operation HFO Consequence

Lubricating Oil:

- High lubricating oil consumption
- Carbon deposit in lubricating oil

Fuel Oil:

- High fuel oil consumption

Spare Parts:

- High wear on engine parts.

Exhaust temperature:

- High exhaust temperature
- High exhaust pressure before turbo charger

Charge Air:

- High charge air pressure

Low-Load Operation HFO Consequence

Cylinder head:

- Valve spindle carbon deposit
- Air and exhaust channel blocking with carbon deposit

Piston:

Piston ring grove blocking op with carbon deposit

Turbo Charger:

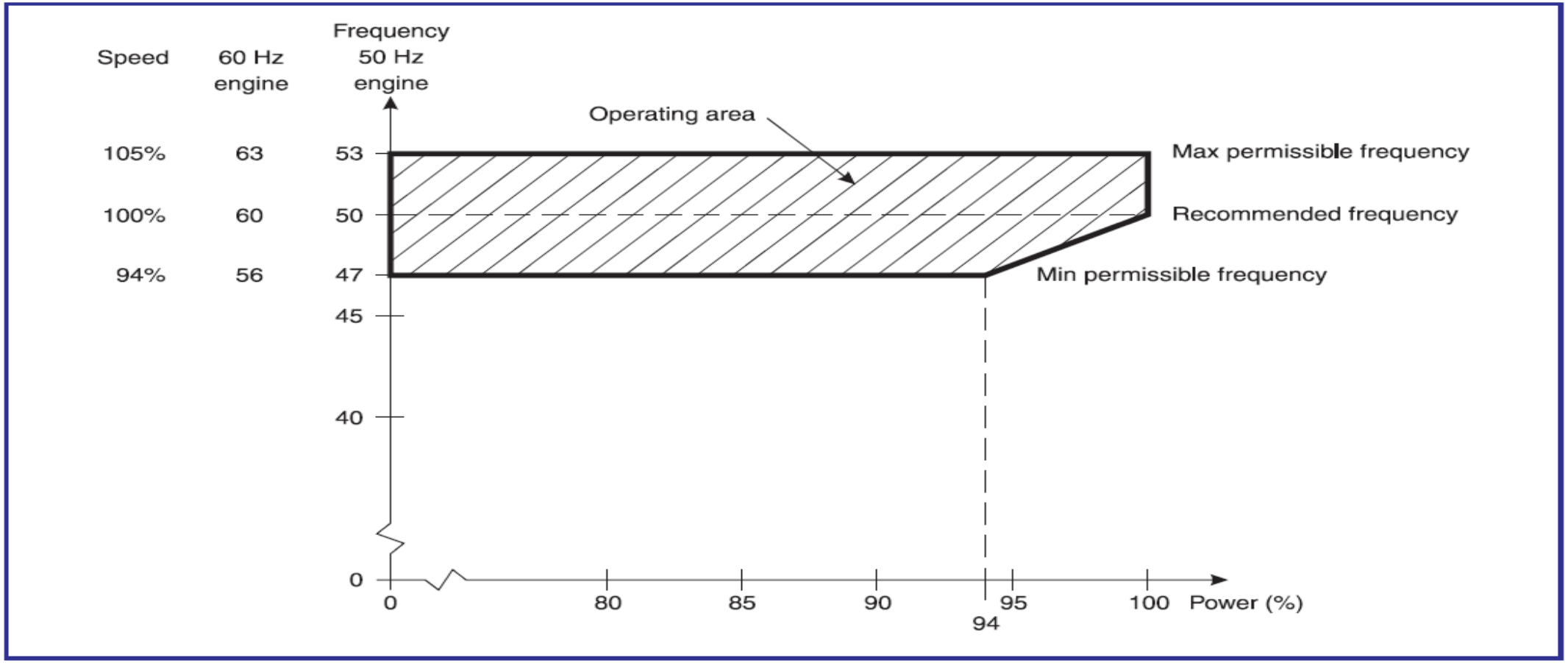
- Nozzle ring blocking up with carbon deposit
- Turbine rotor wheel carbon deposit
- High speed
- Turbo charger stalling at high load

Cylinder liner:

- Scavenging air stage, change to blow back risk of exhaust gas

Charge air cooler: Charge air cooler blocking up

Low Frequency Operation Consequence



Power curve for 50/60 Hz engines.

Low Frequency Operation Consequence

Engine Speed :

Engine speed is lower

Engine Load:

45 Hz (675 rpm), this corresponds to 10% overload.

Firing pressure:

P. Max Firing pressure in cylinder liner is high according to the load.

Fuel Index:

High pressure fuel pump index higher.

Generator:

Generator air cooling fan speed is lower.

Low Frequency Operation Consequence

Mechanic overload at full load:

- Connection rod bearings
- Connection rod
- Piston
- Cylinder head
- Turbocharger

Performance:

- High fuel oil index
- High P - max.
- High exhaust temperature
- High turbo charger speed

Generator:

High winding temperature

Uf, activation 6%, 5 sec. delay

Lubrication Oil Cleaning Separator

- Lub. Oil centrifuge remove particles down to 5 µ.
- Removing water from lub. Oil.

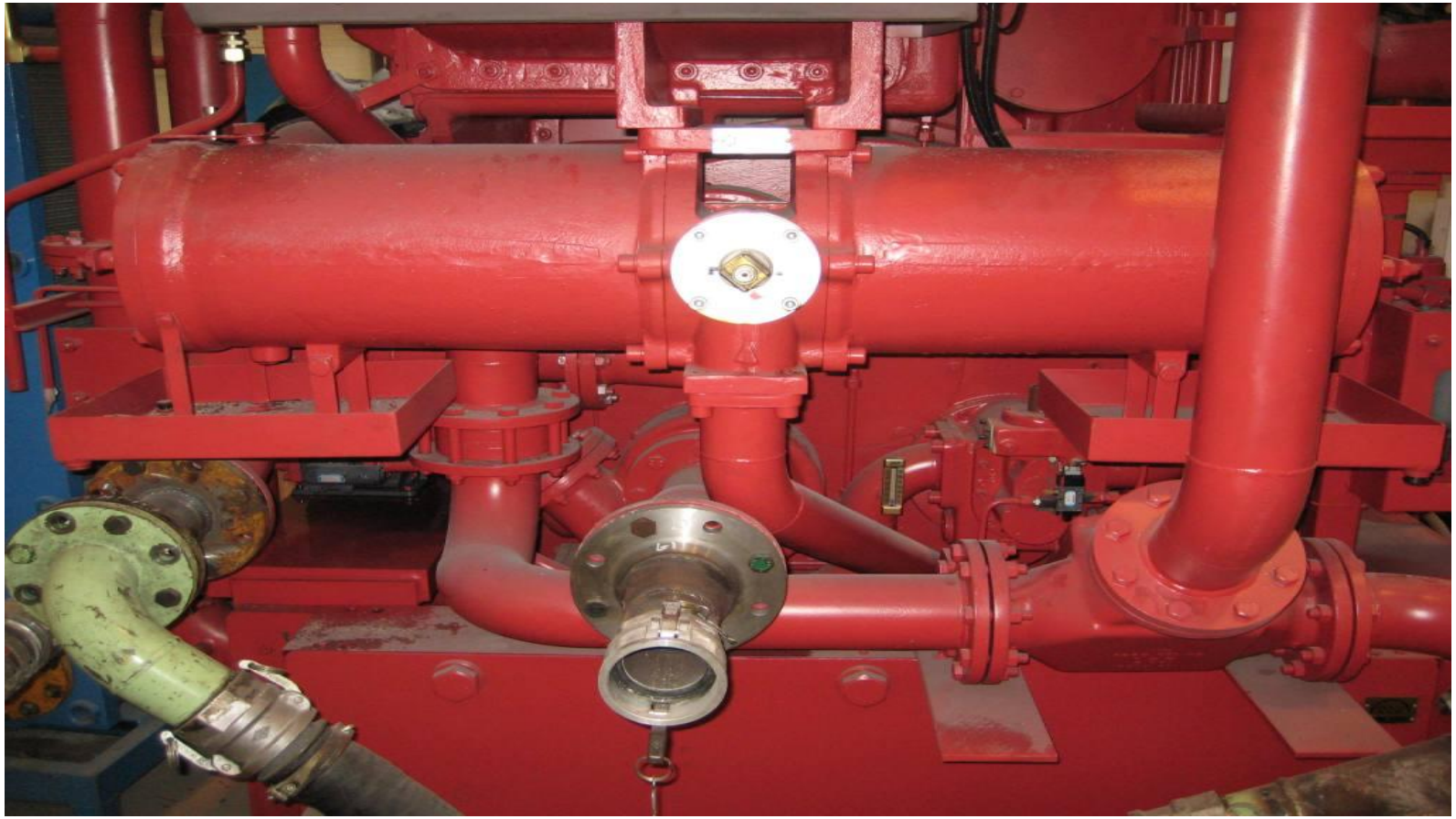
Lubrication Oil Cleaning
Glacier Centrifugal Filter

- Centrifugal lub. Oil filter remove particles down to 5 µ.
- Not removing water

Lubrication Oil Cleaning
Glacier Centrifugal filter

- Glacier centrifugal filter total blocked with particles

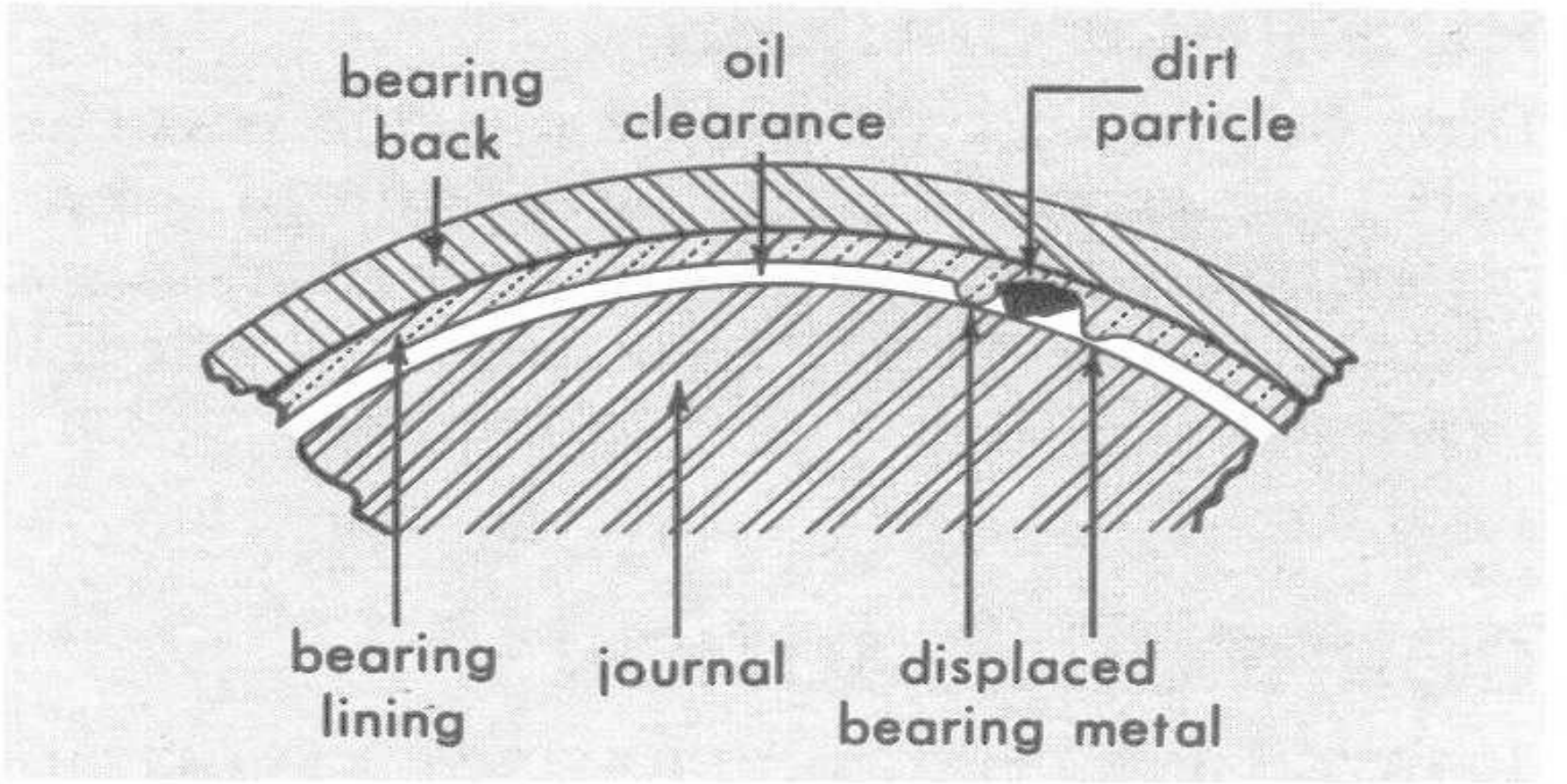
Lubrication Oil Cleaning
Lubrication Oil Filter On Engine



Lubrication Oil Cleaning
Lubrication Oil Filter On Engine

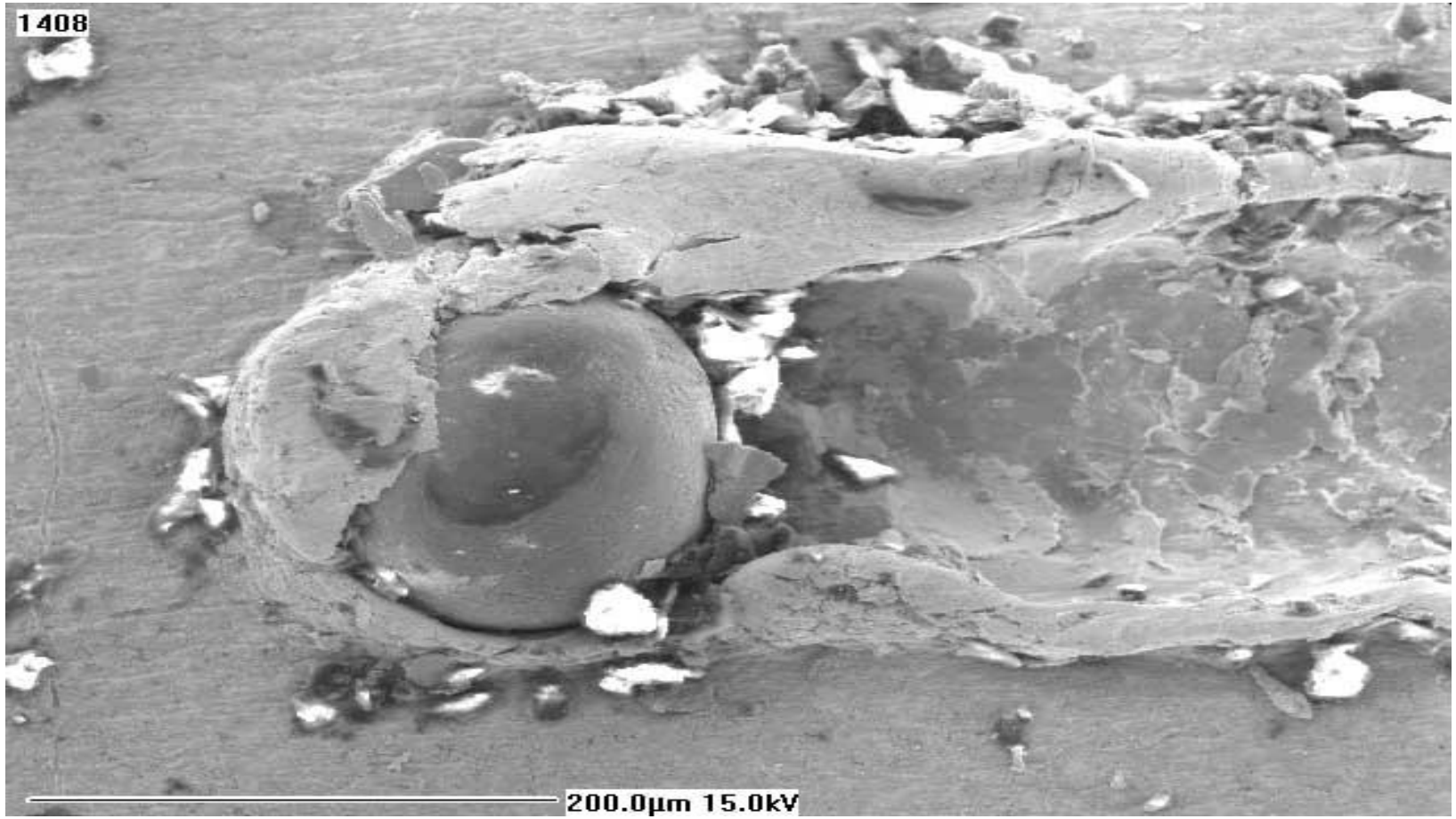
- Engine lub. Oil filter 15 µm. And safety filter 60 µm.

Lubrication Oil Cleaning
Particle in Bearing

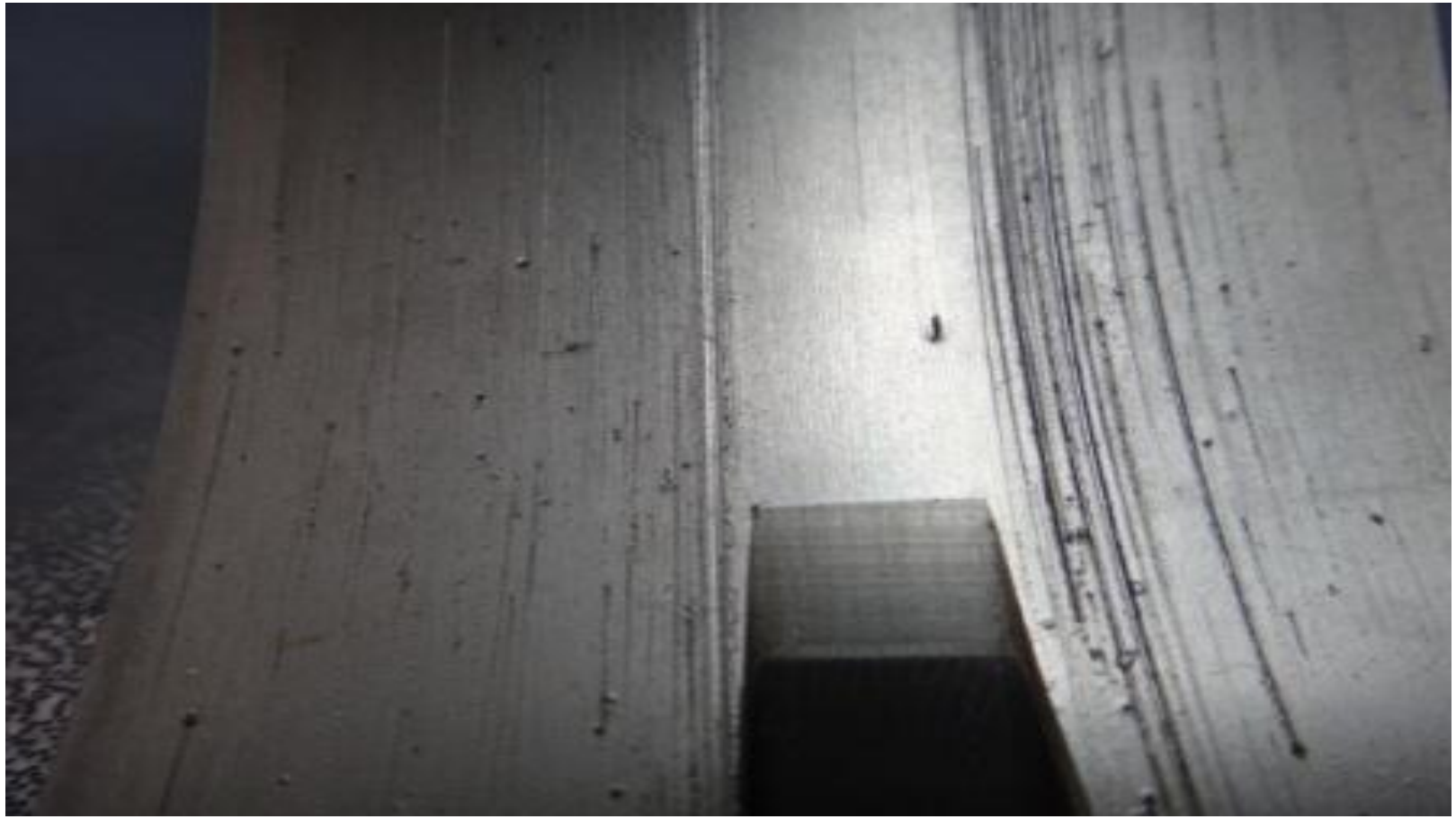


- Particles in bearing - Oil film thickness 2-15 µm.
- Soft bearing martial thickness 0,8 mm.

Lubrication Oil Cleaning
Lubrication Oil Filter On Engine

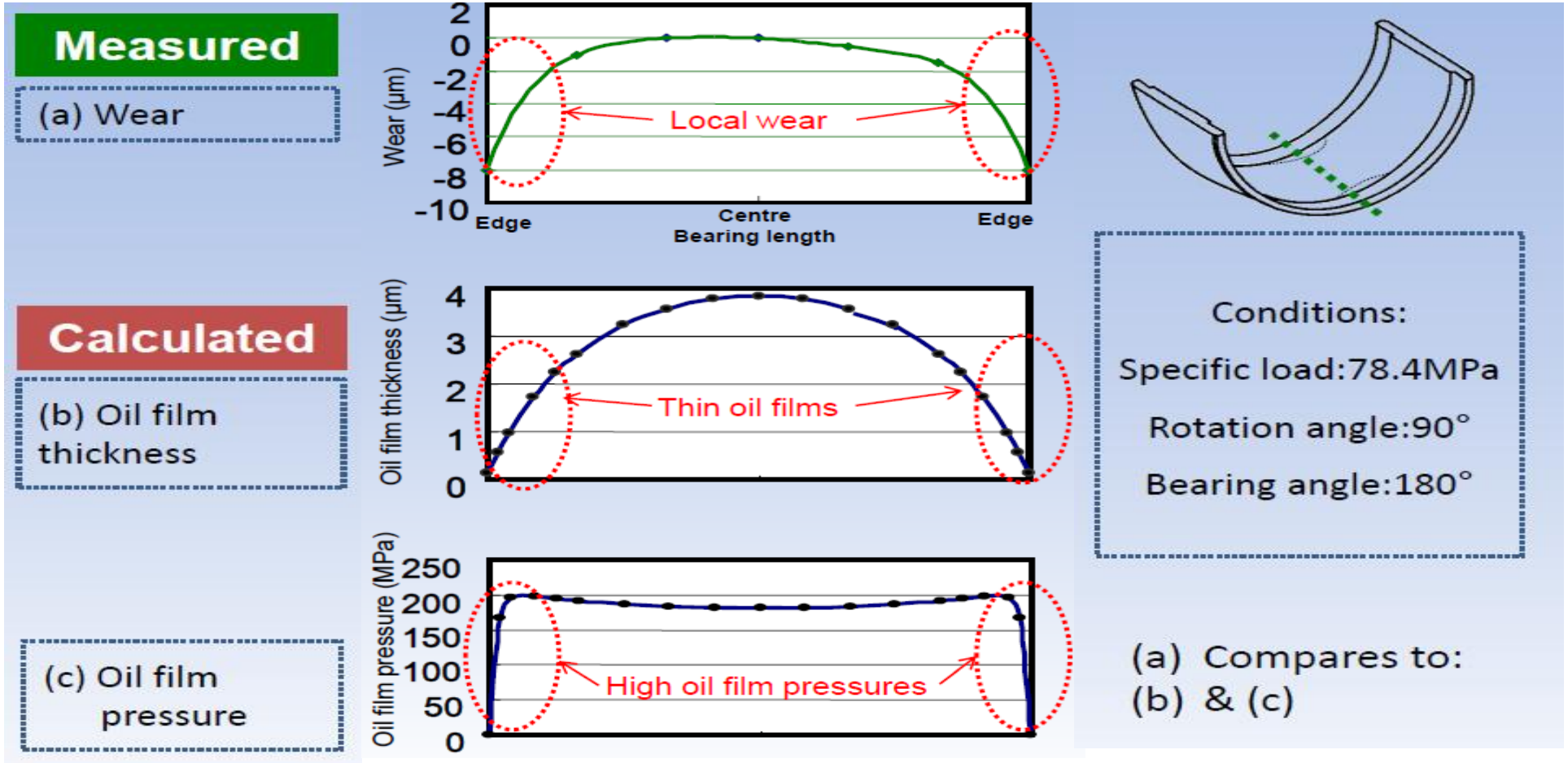


Lubrication Oil Cleaning
Lubrication Oil Filter On Engine

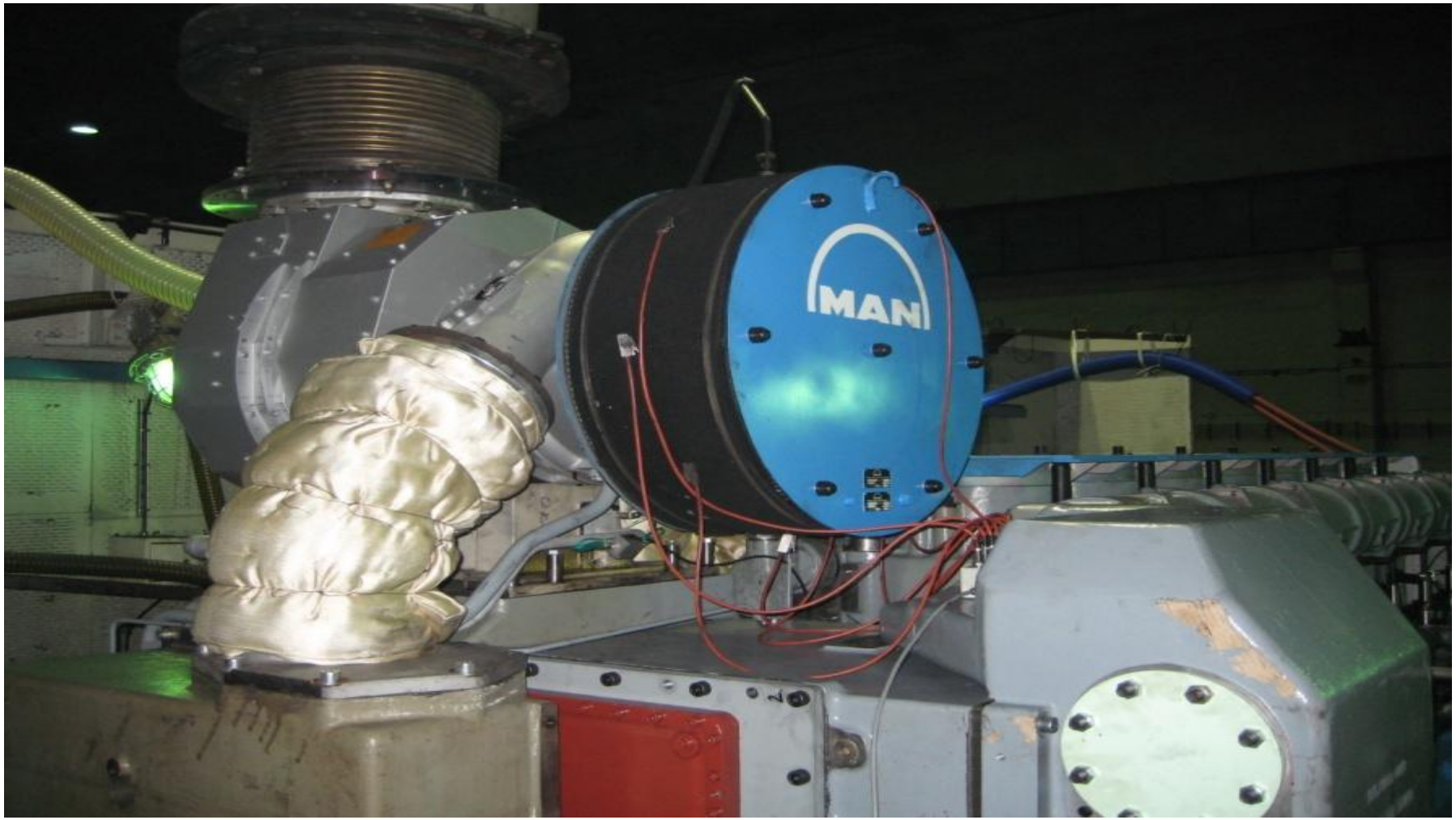


- Particles in bearing

Lubrication Oil Cleaning
Oil Film Thickness

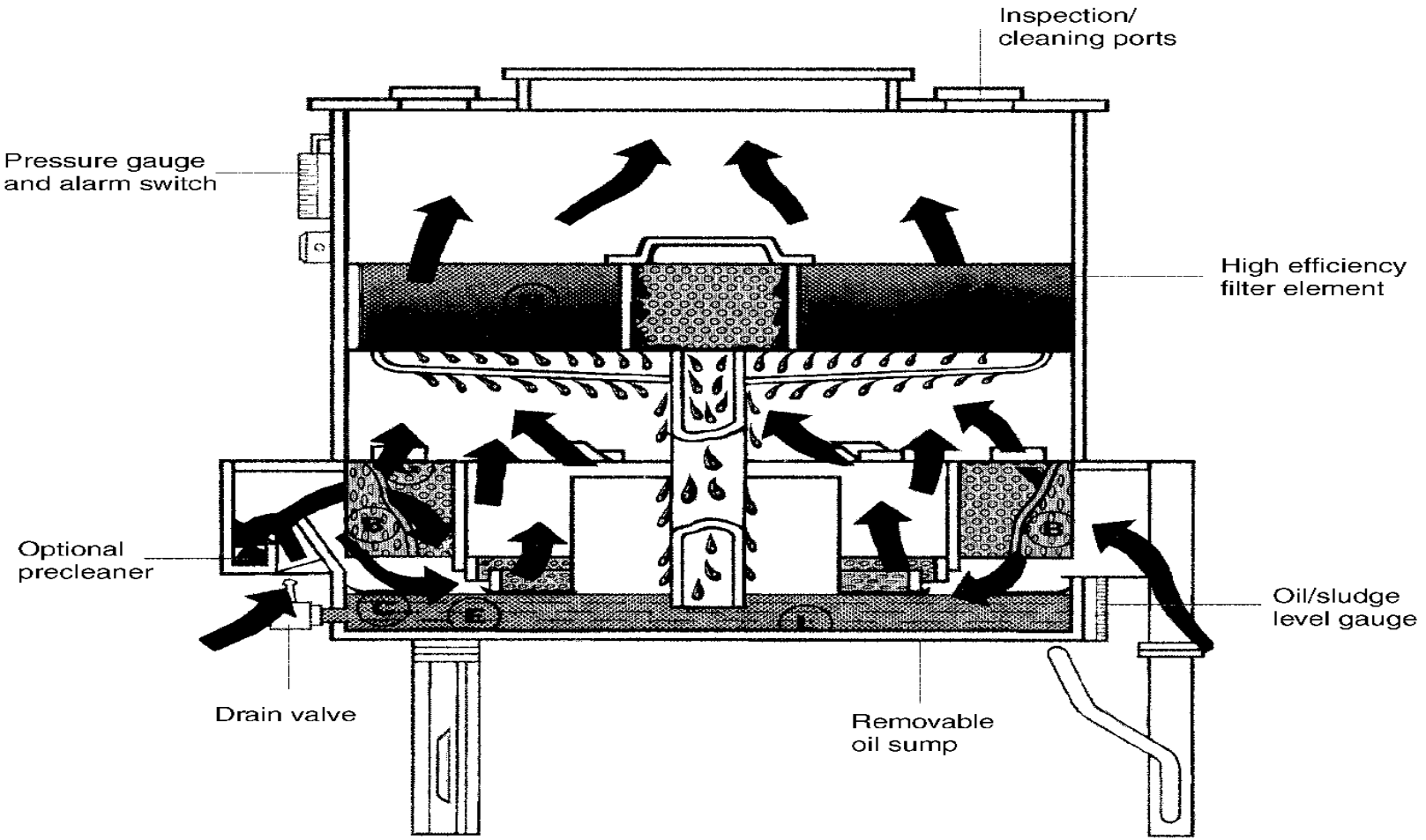


Engine Combustion Air System
Filter Mounted on Engine

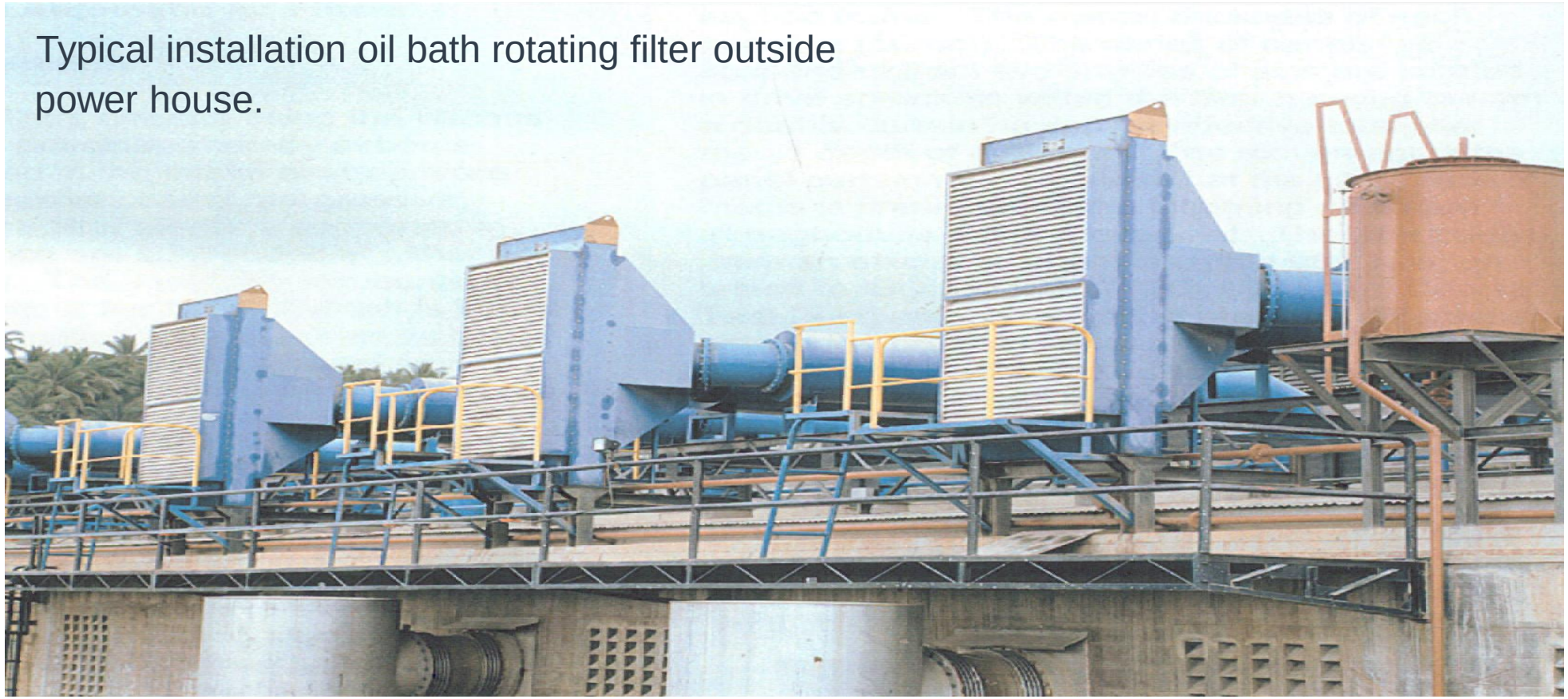


Engine Combustion Air System
Oil Bath Filter

Engine Combustion Air System
Oil Bath Filter

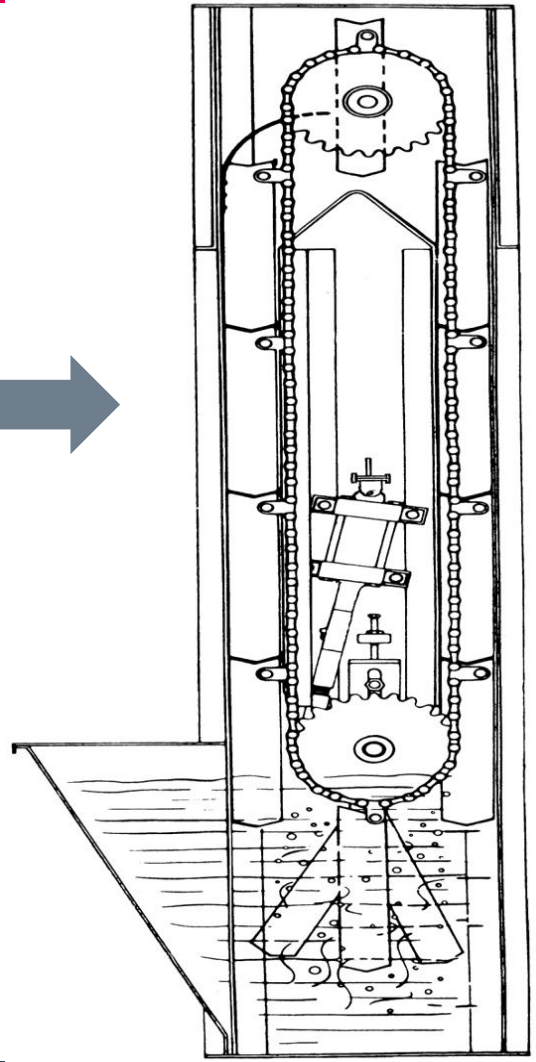


Engine Combustion Air System
Oil Bath Filter



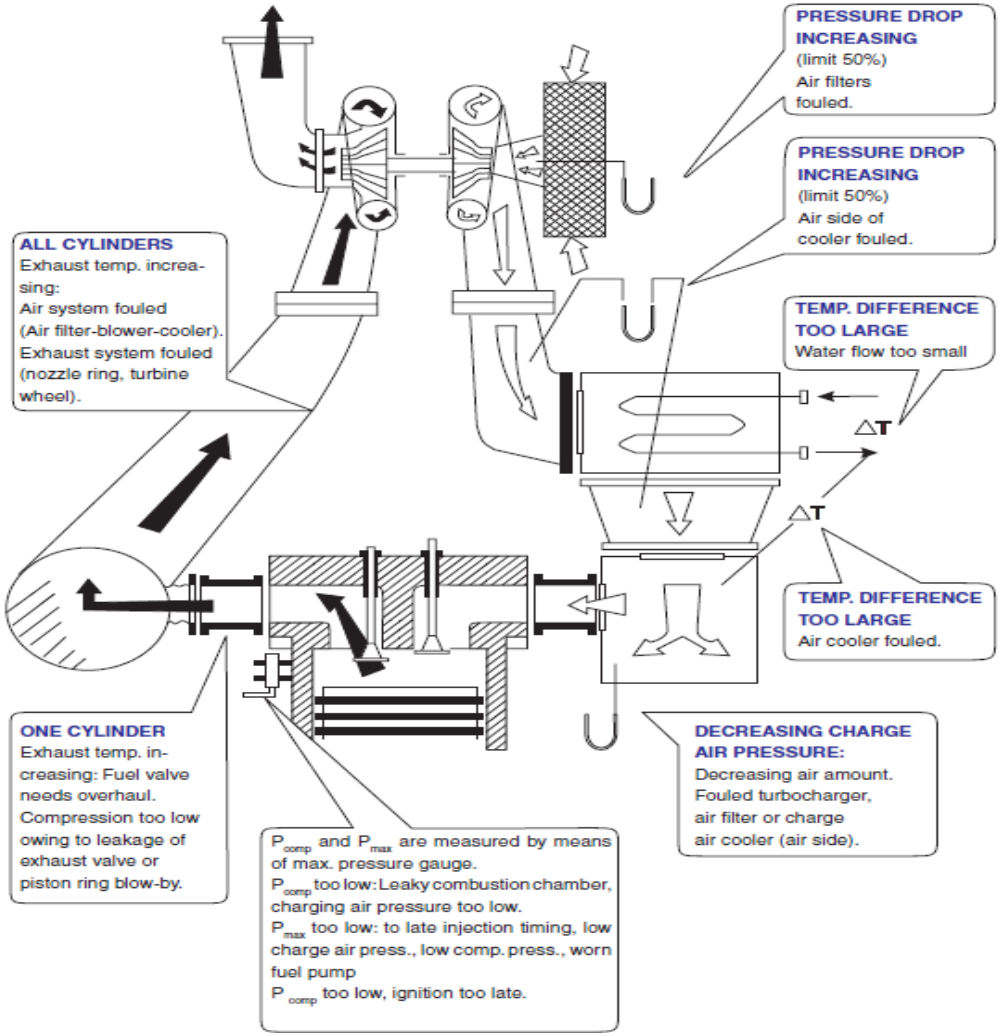
Engine Combustion Air System
Oil Bath Filter

Air flow



Ducting to Engine TC

Evaluation of Readings Regarding Combustion Condition



Performance sheets

MAN Diesel & Turbo
Performance L16/24, L21/31, L27/38 & L28/32H

M/V / Plant:			
Eng. type:		Eng. No:	
T/C type:		Serial No:	
Fuel type:		Viscosity:	
Density:		Date:	

Load	%		
Air temp	°C		
Running hours			
RPM	1/min		
T/C rpm	1/min		
HT temp.	°C		
HT press.	bar		
LT temp.	°C		
LT press.	bar		
LO temp.	°C		
LO press. before filter	bar		
LO press. after filter	bar		
LO press. T/C	bar		
FO temp.	°C		
FO press.	bar		
CA temp.	°C		
CA press.	bar		
Exh. before T/C	°C		
Exh. after T/C	°C		
L1 Phase	°C		
L2 Phase	°C		
L3 Phase	°C		
Governor index			
Power	kW		
Voltage	V		
Current	A		
Cos phi / kwAr			
Crankcase press.	mmWc		

	Exh. °C	Index mm	Pmax * bar	Exh. °C	Index mm	Pmax * bar
Cylinder 1						
Cylinder 2						
Cylinder 3						
Cylinder 4						
Cylinder 5						
Cylinder 6						
Cylinder 7						
Cylinder 8						
Cylinder 9						

* for L16/24 Pmax is not available

Signature:		

Engine Performance Data

1	M/V	2	Engine Type	3	Engine No.	4	Date/Year	5	Hour	6	Total Engine running Hours
7	Engine RPM	8	Visc. Fuel Type Density			9	Turbocharger Type Serial No.			10	Turbocharger RPM

Switchboard

11	Effect (kW)	12	Voltage (V)	13	Current (A)	14	cos ☒/kVAr

Cylinder Data

15	Cylinder No.	1	2	3	4	5	6	7	8	9	16	Ave-rage
17	Fuel Pump Index											
18	Maximum Pressure (bar)											
19	Compress. Pressure (bar)											
20	Exhaust Temp. (° C)											
21	Cooling Water (°C)											

Turbocharger

22	Temp. inlet blower (° C)	23	Pressure before blower (mmWC)	24	Temp. after blower (° C)
25	☒Press. air cooler (mmWC)	26	Temp. charge air (° C)	27	Press. charge air (bar)
28	Temp. exhaust gas before TC (° C)	29	Temp. exhaust gas after TC (° C)	30	Press. exhaust gas after TC (mmWC)

Lubricating Oil System

31	Temp. after engine (° C)	32	Press. before filter (bar)	33	Press. after filter (bar)
34	Temp. inlet engine (° C)	35	Press. before TC (bar)	36	

Cooling Water System

37	LT temp. inlet air cooler (° C)	38	LT temp. outlet air cooler (° C)	39	LT press. inlet air cooler (bar)
40	LT temp. inlet lub. oil cooler (° C)	41	LT temp. outlet lub. oil cooler (° C)	42	LT temp. inlet alternator (° C)
43	LT temp. outlet alternator (° C)	44	HT FW temp. inlet engine (° C)	45	HT FW press. inlet engine (bar)

Fuel Oil System

46	Fuel oil temp. inlet engine (° C)	47	Fuel oil press. before engine (bar)
48	Nozz. cool. oil press. inlet engine (bar)	49	Nozz. cool. oil temp. outlet engine (°C)

50	Sign.

Engine Performance Data

Health Risk!

Warning!
Health Risk! Due to vibrations during engine operation, especially in awkward positions!

The area around the engine

Warning!
The area around the engine must be clean and tidy!

The Instruction for Filling in the Diagram "Engine Performance Data"

The numbers in the instruction are commensurate with the numbers on the diagram.

The automatic symbols mentioned in the instruction TI 01, TI 03, PI 01 etc, refer to the diagrams printed in the instruction books for specified plants.

Engine Performance Data

1) Name of ship, if stationary name of plant.
2) Engine type.
3) Engine no.
4) Date/year of observations.
5) Hour, time of observations.
6) Total engine running hours - engineer's logbook.
7) Engine revolutions per minute (RPM) - can be read on tachometer SI 90.
8) Fuel oil type: The viscosity must be stated (in cSt) and the temperature by which the viscosity has been measured f.inst. 180 cSt/50°C. Density must be stated: g/cm³.
9) Turbocharger: Type and serial number are stated on the rating plate of turbocharger.
10) Turbocharger revolutions per minute (RPM) - can be read on the tachometer SI 89.

Switchboard

11) Effect alternator (kW) - can be read on the main switchboard.
12) Voltage (V) - can be read on the switchboard.
13) Current (A) - can be read on the switchboard.
14) Cos ϕ/kVAr - can be read on the switchboard.

Cylinder Data

15) Cylinder no. - can be read on engine plate. A/B is used for V-engines.
16) Average for all engine cylinders for point: 17-18-19-20-21.
17) Fuel pump index - can be read on each of the high pressure fuel oil injection pumps.
18) Max pressure (bar) can be read for each cylinder by means of indicator or P_{max} gauge.
19) Compression pressure (bar) - can be read for each cylinder by means of the indicator measurement, which is carried out during idling by nominal RPM.
20) Exhaust temperature (°C) - Thermometer TI 60.
21) Water outlet cylinder (°C) (jacket cooling) - Thermometer TI 11.

Turbocharger

22) Thermometer inlet blower (°C) can be read by means of a thermometer placed in the engine room near the air filter of the TC.
23) Pressure before blower (mmWC) - can be read by means of a mmWC instrument placed in the engine room near the TC.
24) Temperature after blower (°C) - can be read by means of a thermometer TI 30.
25) Δ Pressure air cooler (mm/WC).

Engine Performance Data

26) Charge air temperature (°C). Temperature of the charge air in the charge air receiver. - Thermometer TI 31.

27) Pressure charge air (bar). Pressure of the charge air in the charge air receiver. - Pressure gauge PI 31.

28) Tempereture of the exhaust gas before TC (°C) - Thermometer TI 62.

29) Temperature of the exhaust gas after TC (°C) - Thermometer TI 61.

30) Pressure of the exhaust gas after the TC (bar) - Pressure gauge PI 61.

Lubricating Oil System

31) Temperature of the lub. oil inlet cooler (°C) - Thermometer TI 20.

32) Pressure of the lub. oil before the filter (bar) - Pressure gauge PI 21.

33) Pressure of the lub. oil after the filter (bar) - Pressure gauge PI 22.

The filter element should be replaced with a pressure drop across the filter of 1.5 bar.

34) Temperature of the lub. oil inlet engine (°C) - Thermometer TI 22.

35) Pressure of the lub. oil before the turbocharger (bar). - Pressure gauge PI 23.

Cooling Water System

36) Temperature of low temperature (LT) cooling water (sea, raw or fresh) at inlet charge air cooler (°C) - Thermometer TI 01.

37) Temperature of low temperature (LT) cooling water (sea, raw or fresh) at outlet charge air cooler (°C) - Thermometer TI 02.

38) Pressure of the low temperature (LT) cooling water (sea, raw or fresh) at inlet charge air cooler (bar) - Pressure gauge PI 01.

39) Temperature of the low temperature (LT) cooling water (sea, raw or fresh) at inlet lub. oil cooler (°C) - Thermometer TI 07.

40) Temperature of the low temperature (LT) cooling water (sea, raw or fresh) at outlet lub. oil cooler °C) - Thermometer TI 03.

41) Temperature of the low temperature (LT) cooling water (sea, raw or fresh) at inlet alternator (°C) - Thermometer TI 04.

42) Temperature of the low temperature (LT) cooling water (sea, raw or fresh) at outlet alternator (°C) - Thermometer TI 05.

43) Temperature of the high temperature (HT) fresh water (FW) at inlet engine (°C) - Thermometer TI 10.

44) Pressure of the high temperature (HT) fresh water (FW) of outlet engine (°C) - Thermometer TI 10.

Fuel Oil System

45) Temperature of the fuel oil at inlet engine (°C) - Thermometer TI 40.

46) Pressure of the fuel oil before engine (bar) - Pressure gauge PI 40.

47) Nozzle cooling oil pressure at inlet engine (bar) - Pressure gauge PI 50.

48) Nozzle cooling oil pressure at outlet engine (bar) - Pressure gauge PI 51.

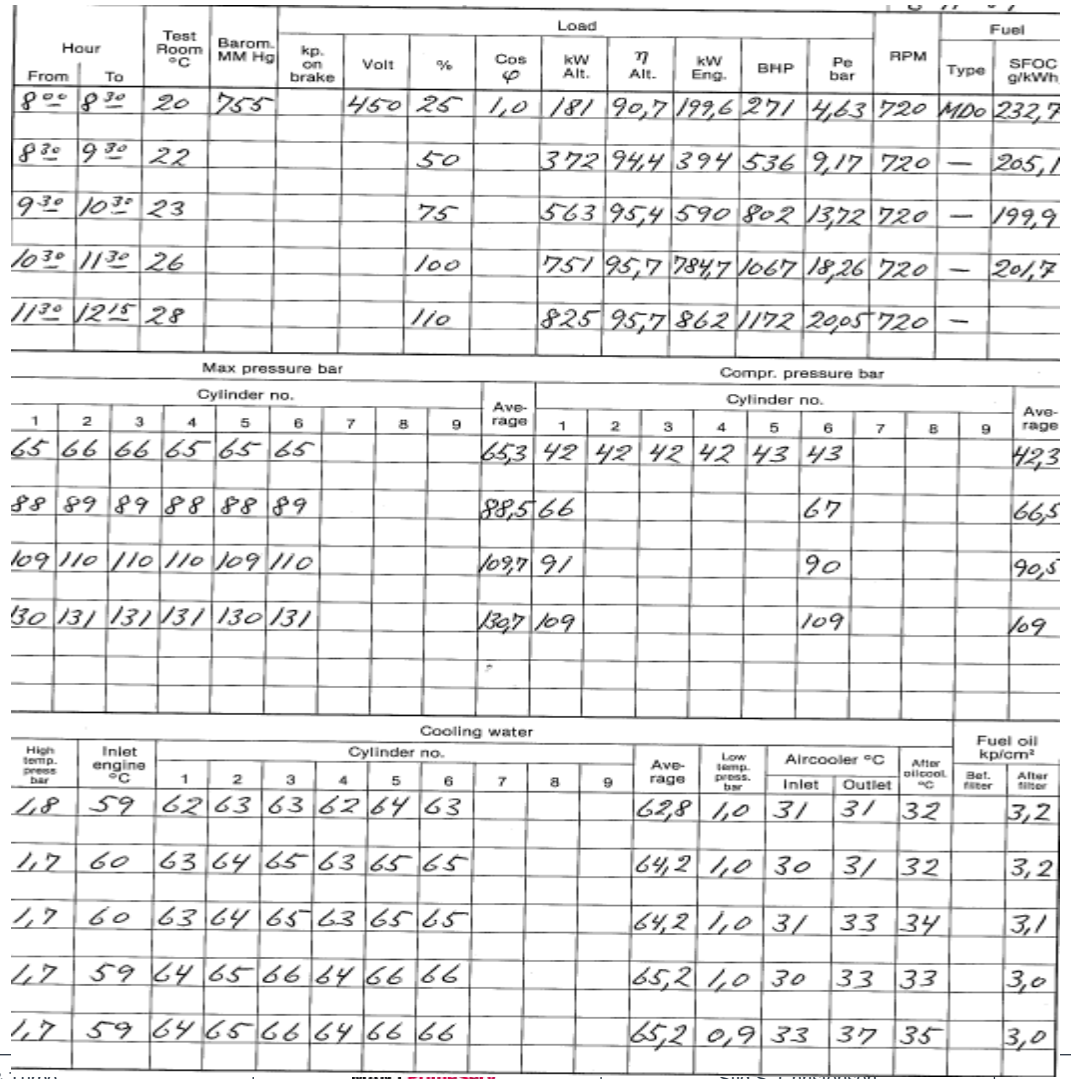
49) Signature.

Operation Data & Set Points 500.30

		Normal Value at Full load at ISO conditions		Acceptable value at shop test or after repair	Alarm Set point		Delay sec.	Autostop of engine	
Lubricating Oil System									
Temp. after cooler (inlet filter)	SAE 40	TI 21	68-73° C	<73° C	TAH 21	80° C	3		
Pressure after filter(inlet engine)		PI 22	4.2-5.0 bar	>4.5 bar	PAL 22	3.5 bar	3	PSL 22 (PSL 22)	3.0 bar (2.5 bar) (D)
Pressure drop across filter		PDAH 21-22	0.1-1 bar	<0.5 bar	PDAH 21-22	1.5 bar	3		
Prelubricating pressure		(PI 22)	0.14-1.4 bar	<1.0 bar	PAL 25	0.12 bar (H)	60		
Pressure inlet turbocharger		PI 23	1.3 - 2.2 bar (C)	>1.3 bar	PAL 23	0.9 bar	3		
Lub. oil level in base frame					LAL 28 LAH 28	Low level High level	30 30		
Pressure before filter		PI 21	4.5-5.5 bar						
Crankcase protection					LAH 92 TAH 92 TDAH 92	High level (K) 75° C (K) 2° C (K)	3 3 3	LSH 92 TSH 92 TDSH 92	High level (K) 78° C (K) 3° C (K)
Temp. main bearing		TI 29	80-95° C		TAH 29	100° C (K)	3	TSH 29	105° C (K)
Fuel Oil System									
Pressure after filter	MDO HFO	PI 40 PI 40	3-6 bar 5-16 bar (A)		PAL 40 PAL 40	2 bar 4-6 bar (E)	5 5		
Leaking oil					LAH 42	High level	5		
Temperature inlet engine	MDO HFO	TI 40 TI 40	30-40°C 110-150°C						
Cooling Water System									
Press. LT system, inlet engine		PI 01	2.5-4.5 bar	>1.8 bar	PAL 01	0.4 + (B) bar	3		
Press. HT system, inlet engine		PI 10	2.0-5.0 bar	>1.8-<6 bar	PAL 10	0.4 + (B) bar	3		
Temp. HT system, outlet engine		TI 12	75-85°C	<85° C	TAH 12 TAH 12-2	90° C 93° C	3 3	TSH 12 (TSH 12)	95° C (D) (100° C)
Temp. LT system, inlet engine		TI 01	30-40°C						
Exhaust Gas and Charge Air									
Exh. gas temp. before TC		TI 62	480-530° C		TAH 62 TAH 62-2	570° C 620° C	10 3		
Exh. gas temp. outlet cyl.		TI 60	350-450° C		TAH 60	465° C	3		
Diff. between individual cyl.			average ± 30° C	average ±25° C	TAD 60	average (L) ± 50° C	60		
Exh. gas temp. after TC 330 kW/cyl 300-320 kW/cyl		 TI 61 TI 61	 275-400° C 275-375° C		 TAH 61 TAH 61	 450° C 450° C	 3 3		
Ch. air press. after cooler		PI 31	2.8-3.1 bar						
Ch. air temp. after cooler		TI 31	40-55° C	<55° C					
Compressed Air System									
Press. inlet engine		PI 70	8- 10 bar	>7.5-<10 bar	PAL 70	7.5 bar	15		

10° C change in ambient temperature correspond to approx. 15° C exhaust gas temperature change

Filled in performance sheet



Hour From	Hour To	Test Room °C	Barom. MM Hg	Load: kp. on brake	Volt	%	Cos φ	kW Alt.	η Alt.	kW Eng.	BHP	Pe bar	RPM	Fuel: Type	Fuel: SFOC g/kWh
8 00	8 30	20	755		450	25	1,0	181	90,7	199,6	271	4,63	720	MDO	232,7
8 30	9 30	22				50		372	94,4	394	536	9,17	720	—	205,1
9 30	10 30	23				75		563	95,4	590	802	13,72	720	—	199,9
10 30	11 30	26				100		751	95,7	784,7	1067	18,26	720	—	201,7
11 30	12 15	28				110		825	95,7	862	1172	20,05	720	—	

Max pressure bar

Cylinder no. 1	2	3	4	5	6	7	8	9	Average
65	66	66	65	65	65				65,3
88	89	89	88	88	89				88,5
109	110	110	110	109	110				109,7
130	131	131	131	130	131				130,7

Compr. pressure bar

Cylinder no. 1	2	3	4	5	6	7	8	9	Average
42	42	42	42	43	43				42,3
66					67				66,5
91					90				90,5
109					109				109

Cooling water

High temp. press bar	Inlet engine °C	Cylinder no. 1	2	3	4	5	6	7	8	9	Average	Low temp. press. bar	Aircooler °C Inlet	Aircooler °C Outlet	After oilcool. °C	Fuel oil kp/cm² Bef. filter	Fuel oil kp/cm² After filter
1,8	59	62	63	63	62	64	63				62,8	1,0	31	31	32		3,2
1,7	60	63	64	65	63	65	65				64,2	1,0	30	31	32		3,2
1,7	60	63	64	65	63	65	65				64,2	1,0	31	33	34		3,1
1,7	59	64	65	66	64	66	66				65,2	1,0	30	33	33		3,0
1,7	59	64	65	66	64	66	66				65,2	0,9	33	37	35		3,0

Filled in performance sheet

Turbocharger (T/C)											Lubricating oil				
RPM	Press. after turbine MM WC	Temperature °C					Pressure				Press. bar			Temp. °C	
		Before turbine	After turbine	Inlet blower	After blower	After cooler	ΔP filter MM WC	ΔP cooler MM WC	After cooler MM HG	After cooler M.WC	Bef. filter	Aft. filter	Bef. T/C	Bef. cooler	Aft. cooler
22080	1		268	31	56	34		41	239	3,2	4,9	4,7	1,70	64	57
33660	2		278	30	92	34		71	655	8,9	4,75	4,6	1,80	65	54
42780	2		278	32	143	35		95	1160	15,7	4,7	4,5	1,73	65	53
49440	2		302	34	183	35		111	1615	21,9	4,7	4,5	1,80	65	51
52500	2		330	36	205	39		115	1798	24,4	4,65	4,45	1,80	66	57

Exhaust temperature °C										Fuel pump index										Governor
Cylinder no.									Average	Cylinder no.									Average	Load index
1	2	3	4	5	6	7	8	9		1	2	3	4	5	6	7	8	9		
225	215	220	230	210	210				218	10	10	10	10,5	10,5	10				10,2	2,95
245	235	245	245	240	240				242	15	15	14,5	15	15	14				14,8	4,50
265	250	260	260	265	260				260	20,5	20,5	20	20,5	20,5	20				20,3	6,20
320	305	310	315	320	310				313	25,5	25,5	25	26	26	25				25,5	7,9
360	350	350	365	370	350				357	28,5	28,5	28	29	29	28				28,5	8,8

Governor Make: Woodward

Type LIG8; R. 8521-367 No. 2275224

Speed droop: 44 Compensation: 2

Needlevalve turn open: 1 1/4 Overspeed Rpm: 825

Servo Motor: 230 Volt AC – DC

Shutdown: 24 Volt DC – Engz.

D.E. Cyl. coefficient 0,01326

Name of fuel oil MDO

Fuel spec. gravity 0,84 – 15 °C

Kcal./kg

Name of system oil

Waterbrake coefficient

Prelub. Pump Serial No.: ABB. 6919683

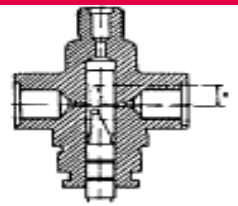
Remarks:

Governor Test						
Load %		Speed Variation				
From	To	Before RPM	Momen. RPM	Diff. %	Perman. RPM	Diff. %
100	0	720	780	8,33	747	3,75
0	50	747	710	4,95	734	1,74
50	100	734	690	5,99	719	2,04

T/C Make	MAN
Type	NR 15 / R 184
Specifikation	W. nr: 1180 938
Max. RPM	57000
Max. gas temp.	650 °C!

Filled in performance sheet

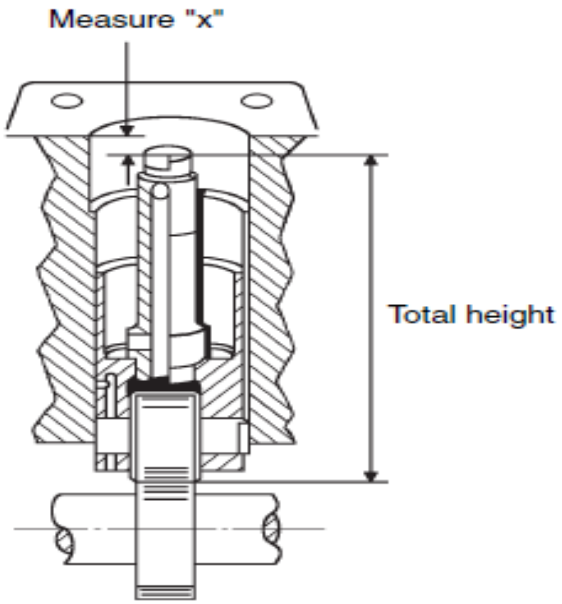
Lead of fuel pump measured as lift of fuel pump plunger from its lowest position to ist position when engine piston is in ignition top dead centre

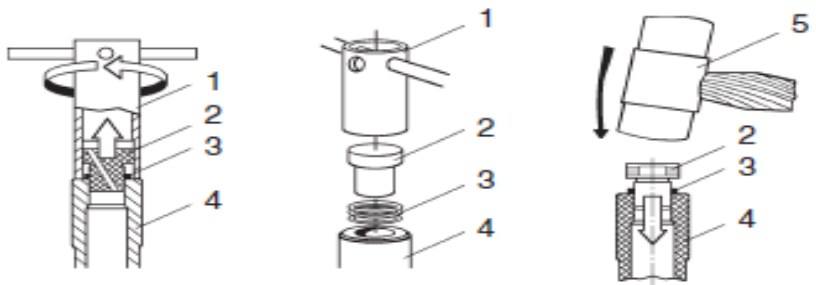


Cylinder no.	A1 / B1	A2 / B2	A3 / B3	A4 / B4	A5 / B5	A6 / B6	A7 / B7	A8 / B8	A9 / B9
Lead of fuel pump (A)	9,2	9,2	9,2	9,2	9,2	9,2			
Fuel pump index with handle in stop	÷1,5	÷2,5	÷2	÷2	÷2,5	÷1,5			
Fuel pump index by max. supply of fuel oil	29,5	29,5	29	30	30	29			
Liner under fuel pump X =	7,9	7,5	7,5	7,7	7,8	7,5			
Measure on piston top	1,5	1,3	1,3	1,3	1,3	1,4			

ATOMIZER	ADJUSTMENT AFTER THE TRIAL
	Marked: LTO-BHE/E Drwg. no.: 882136-6 holes of 8×0,32 mm
Clearance for inlet valve	0,5 mm
Clearance for exhaut valve	0,9 mm

Adjustment of Pmax





1	Extractor	2	Thrust piece
3	Shims	4	Roller guide
5	Soft hammer		

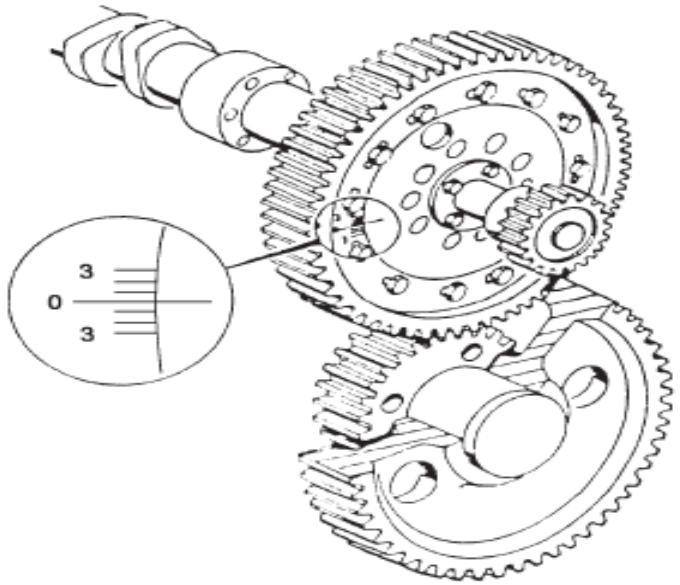
If P_{max} is too high it indicates that the injection timing is advanced.

If P_{max} is too high it indicates that the injection timing is advanced.

By changing "X" with 0.10 mm the maximum combustion pressure is changed with

How to adjust Pmax.

Action	Results		
Total height on roller guide	Distance "x"	Injection timing	Max. combustion pressure
increased ↑	Reduced ↓	Advanced ↑	increased ↑
Reduced ↓	increased ↑	Delayed ↓	Reduced ↓



When the screws, which fasten the gear wheel, are loosened the gear wheel is turned (by turning the crankshaft) in relation to the camshaft. By reading the angle in which the gear wheel is displaced in relation to the camshaft the altered Pmax can be calculated. A line on the scale corresponds to: see page 600.35.

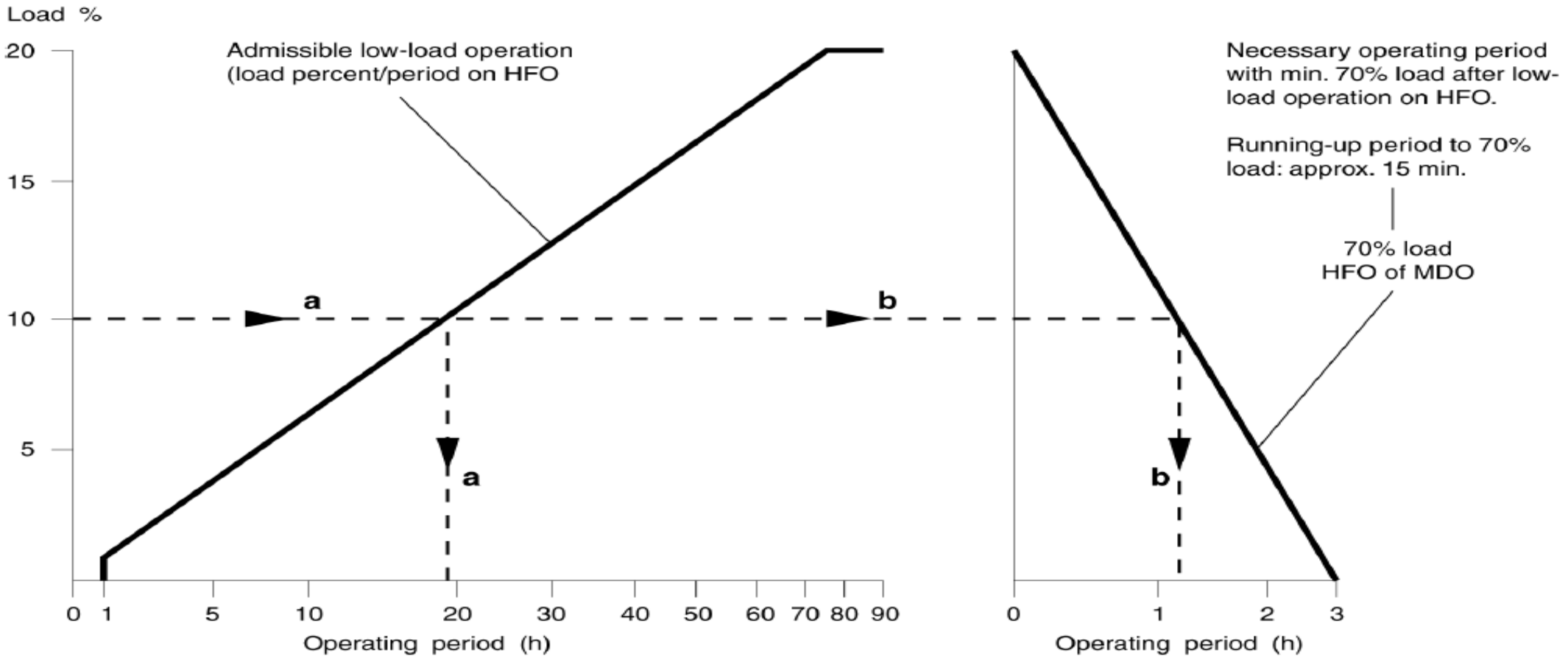
If the crankshaft is turned in the engines normal direction of rotation the maximum combustion pressure P-max. is reduced.

If the crankshaft is turned against the engines normal direction of rotation the maximum combustion pressure P-max. is increased.

Data for pressure and tolerances 600.35

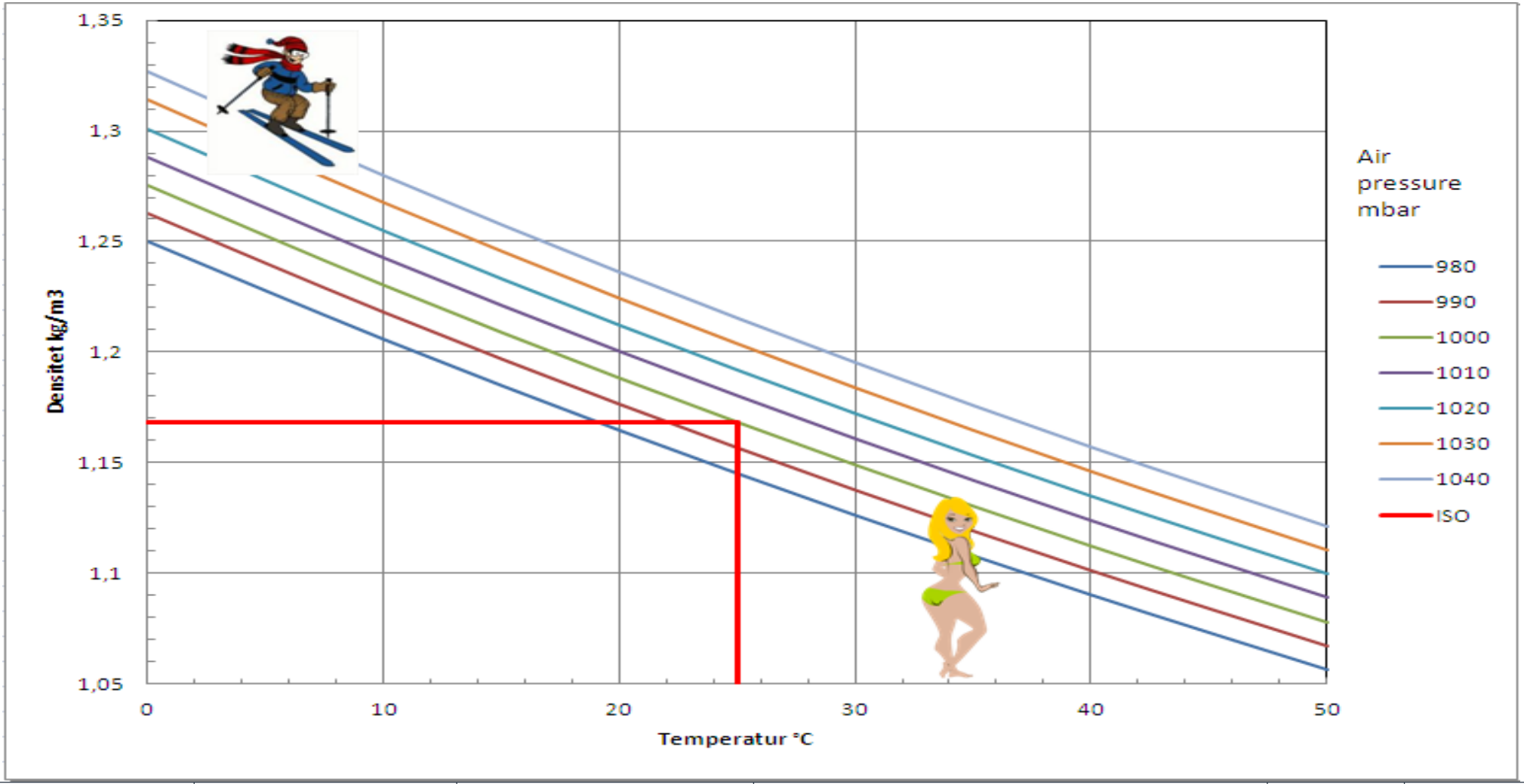
Section	Description	mm. / bar
614	Maximum combustion pressure at full load	Max 133 bar
	Individual cylinders; admissible deviation from average	± 3 bar
	A change of the height of the thrust piece spacer ring of 0.10 mm. will change the maximum pressure by	1 bar
	1° turning of camshaft gear wheel changes max. pressure by approx	6 bar
	Measurement "X" between thrust piece and roller guide housing	11 ± 0.2 mm
	Opening pressure of fuel valve	320 bar
	Pressure testing, cooling oil sealing, on fuel valve	100 bar

Part load/low load operation

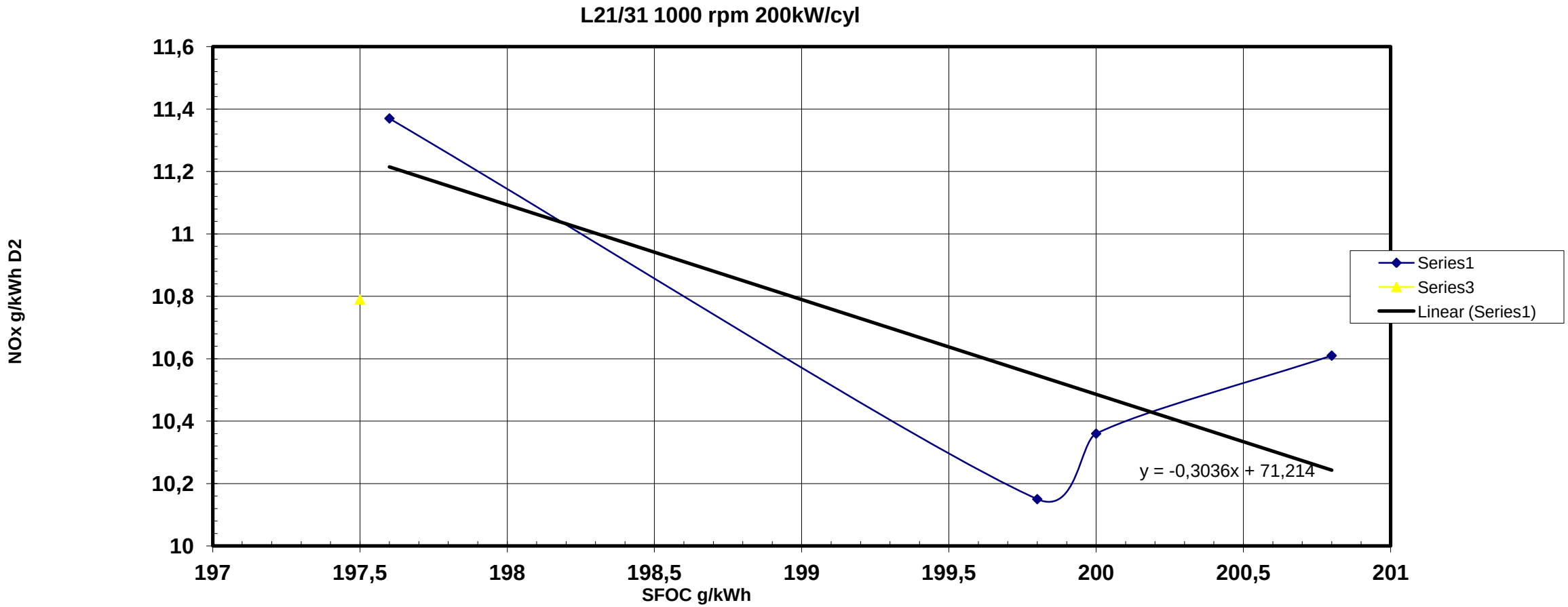


Example: a) with 10% load 19 hours maximum operation on HFO admissible, then change-over to MDO
or b) operate engine for approx. 1.2 hours with 70% rating minimum, in order to burn off residues.
Afterwards low load operation on HFO can be continued.

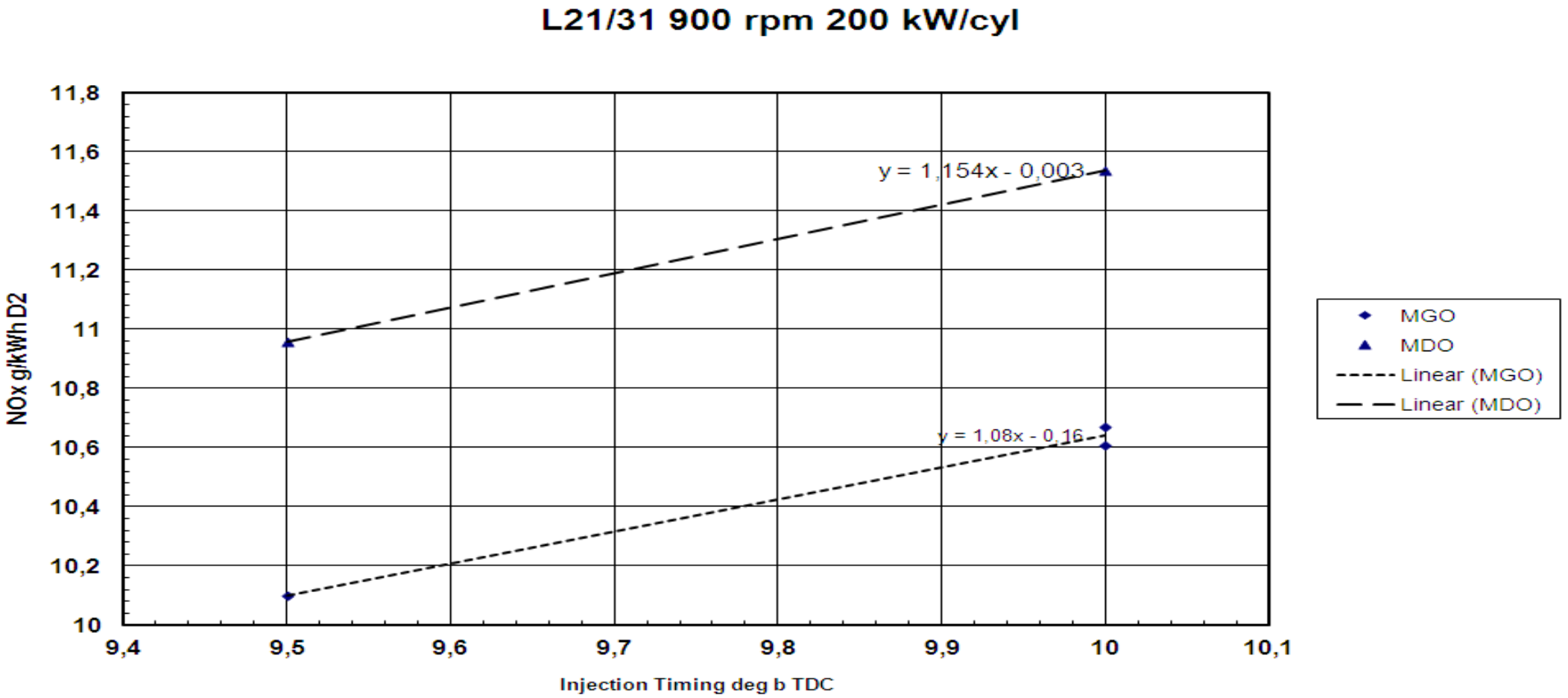
Density of air



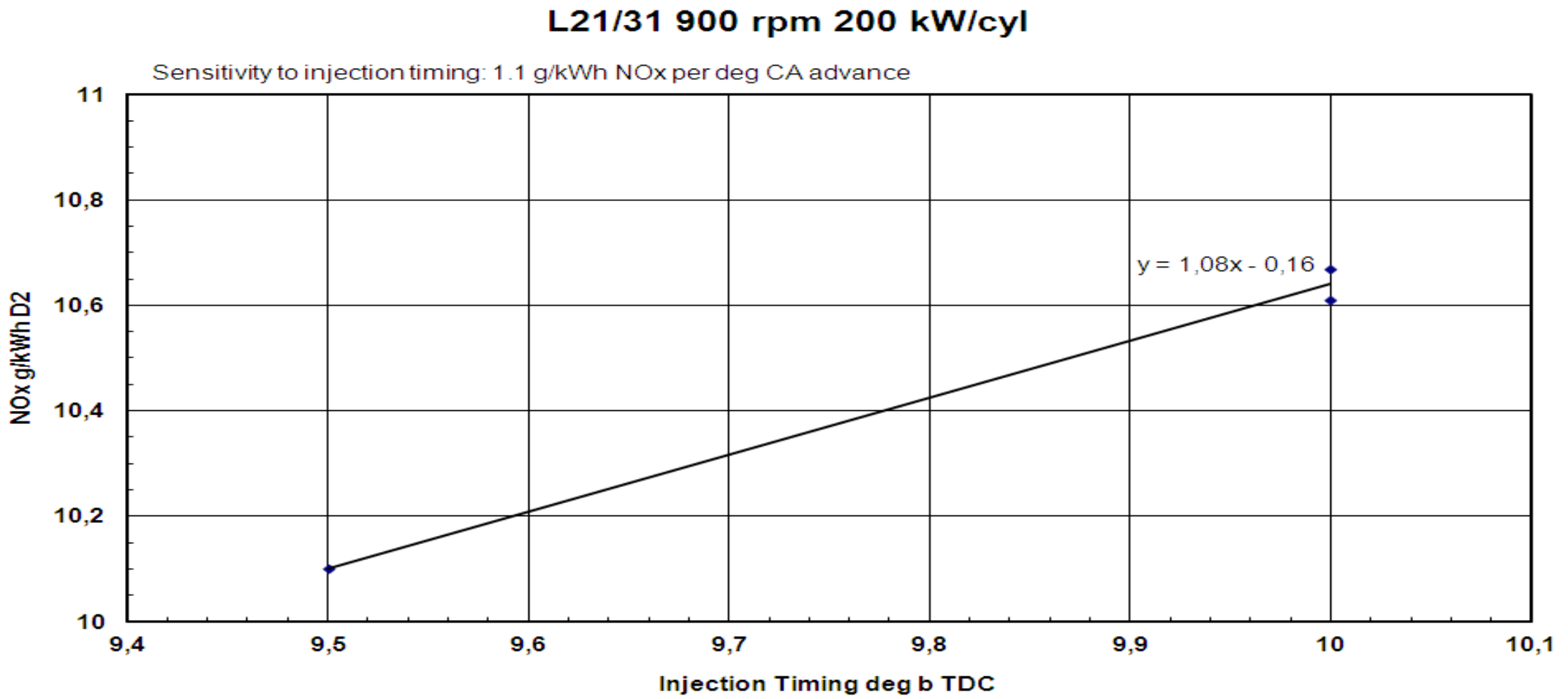
NOx vs. SFOC


L21/31 1000 rpm 200kW/cyl
NOx g/kWh D2
11,6
11,4
11,2
11
10,8
10,6
10,4
10,2
10
197
197,5
198
198,5
199
199,5
200
200,5
201
SFOC g/kWh
Series1
Series3
Linear (Series1)
y = -0,3036x + 71,214

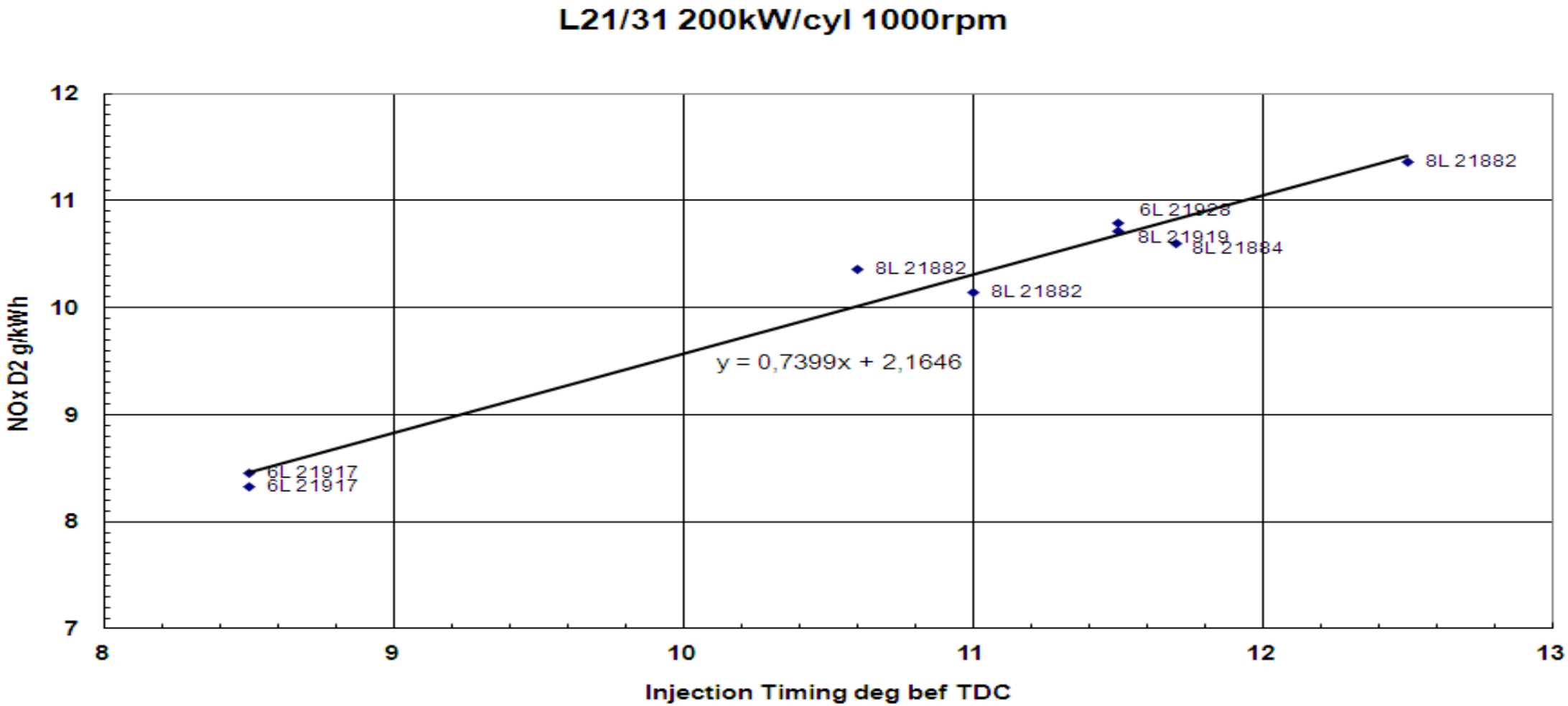
Emission related to MGO and MDO



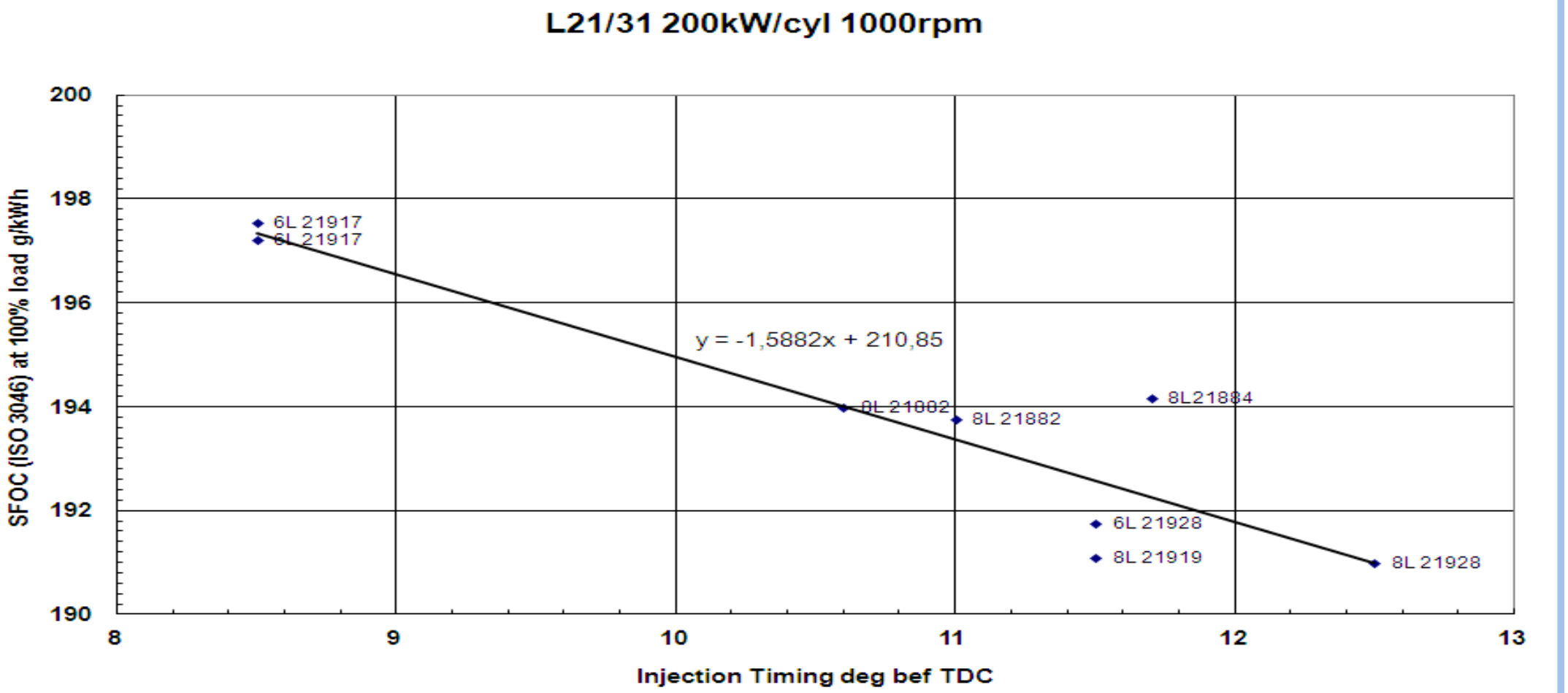
Injection timing vs. NOx (g/kWh)



NOx vs. Advanced injection



SFOC vs. Injection Timing

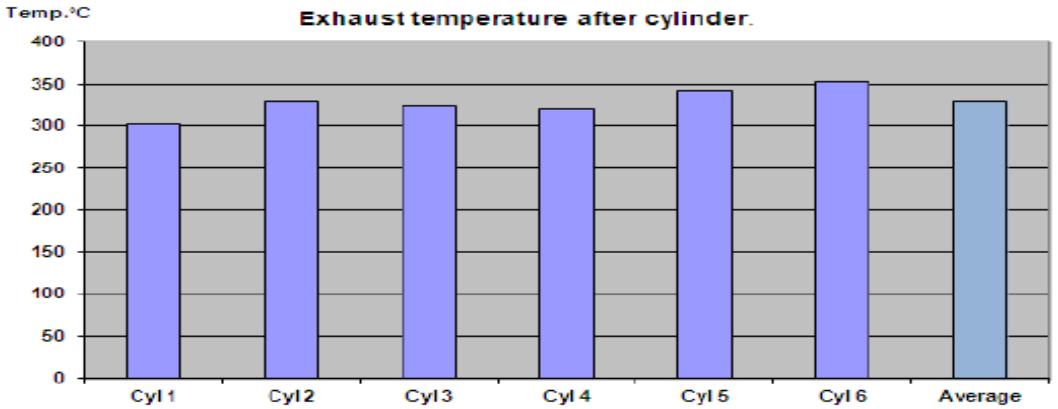


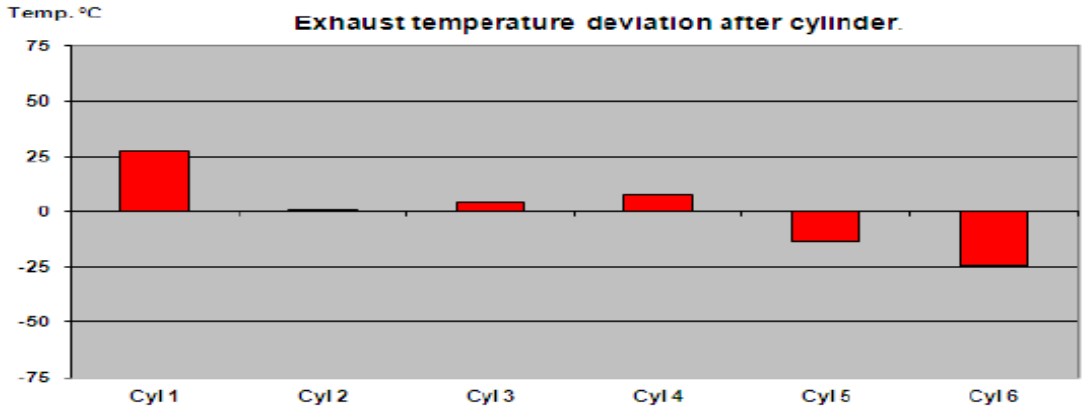
Exhaust gas temperatures

Exhaust gas temperature after cylinder:

Purpose for measurement:

1. To check equal cylinder loading, Index adjustment
2. Detect valve tightness, burned valve seats
3. Detect malfunction of fuel atomizers.
4. Detect malfunction of fuel pumps, wear and timing.





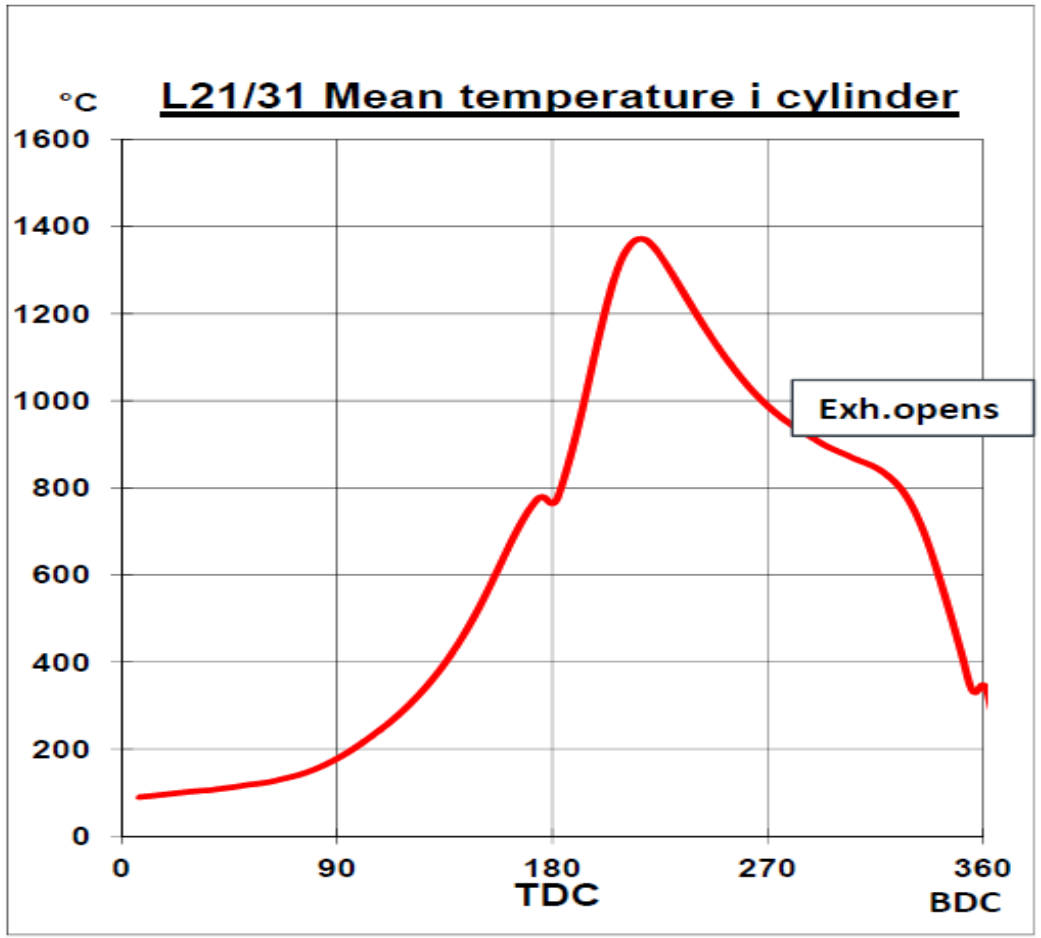
Exhaust gas temperatures

Exhaust gas temperature after cylinder:

Exhaust temperature varies from exhaust valve opens where the temperature is about 800°C down to around 200°C at the end of the valve overlap.

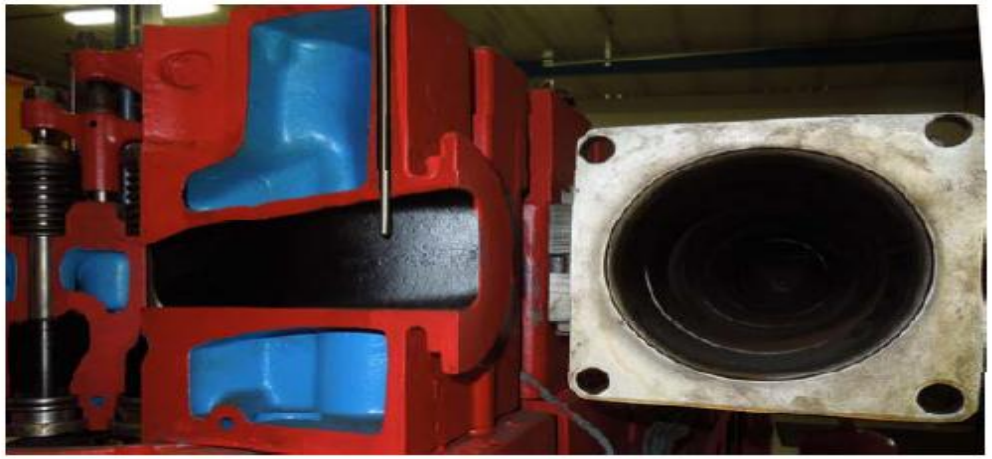
Temperature in cylinder shown in diagram

MNS

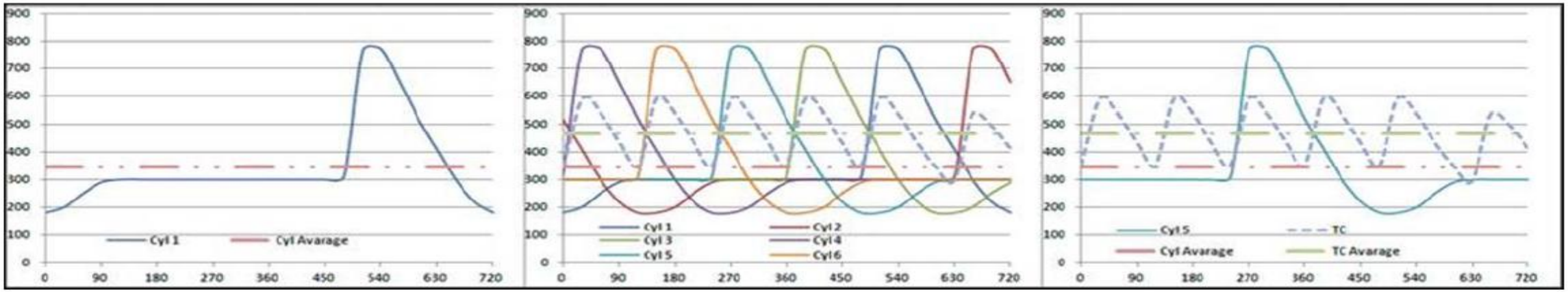


Exhaust gas temperatures

Why is the exhaust gas temperature higher before TC than after cylinders?

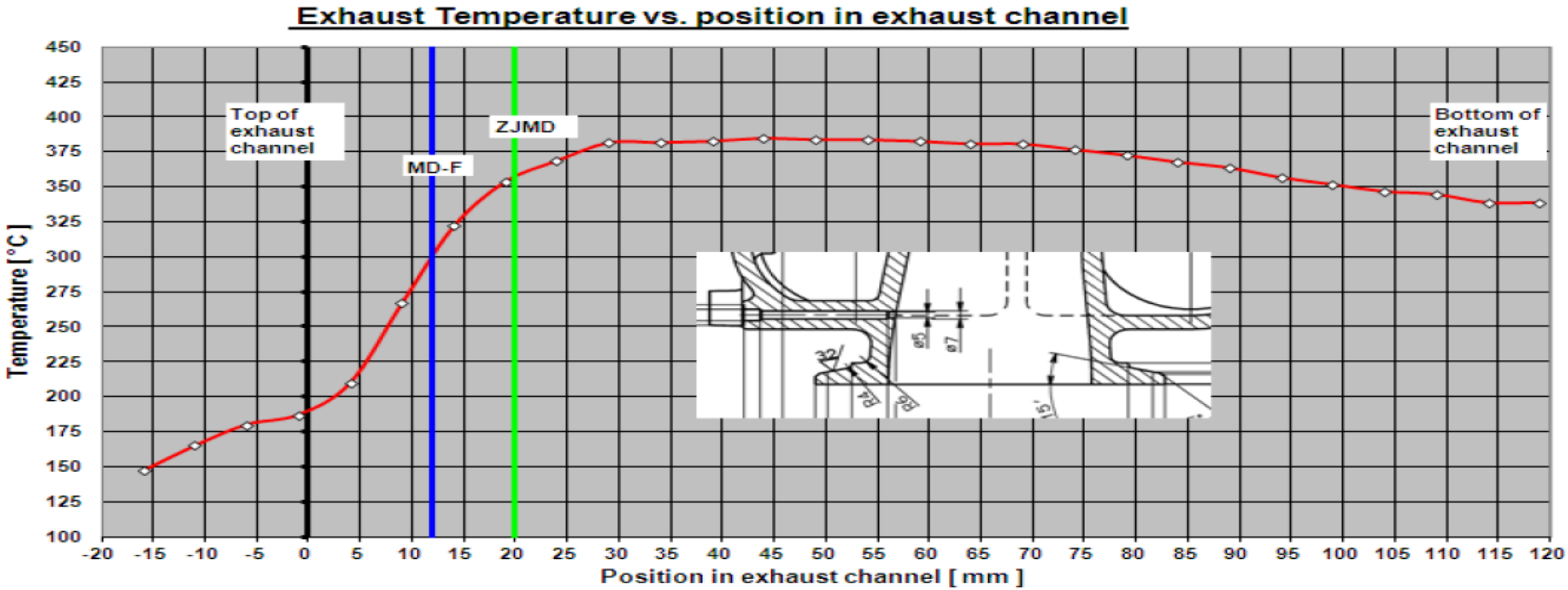


- The temperature after cylinder is time based mean average.
- The temperature before turbine is the mean temperature of all cylinders and therefore higher



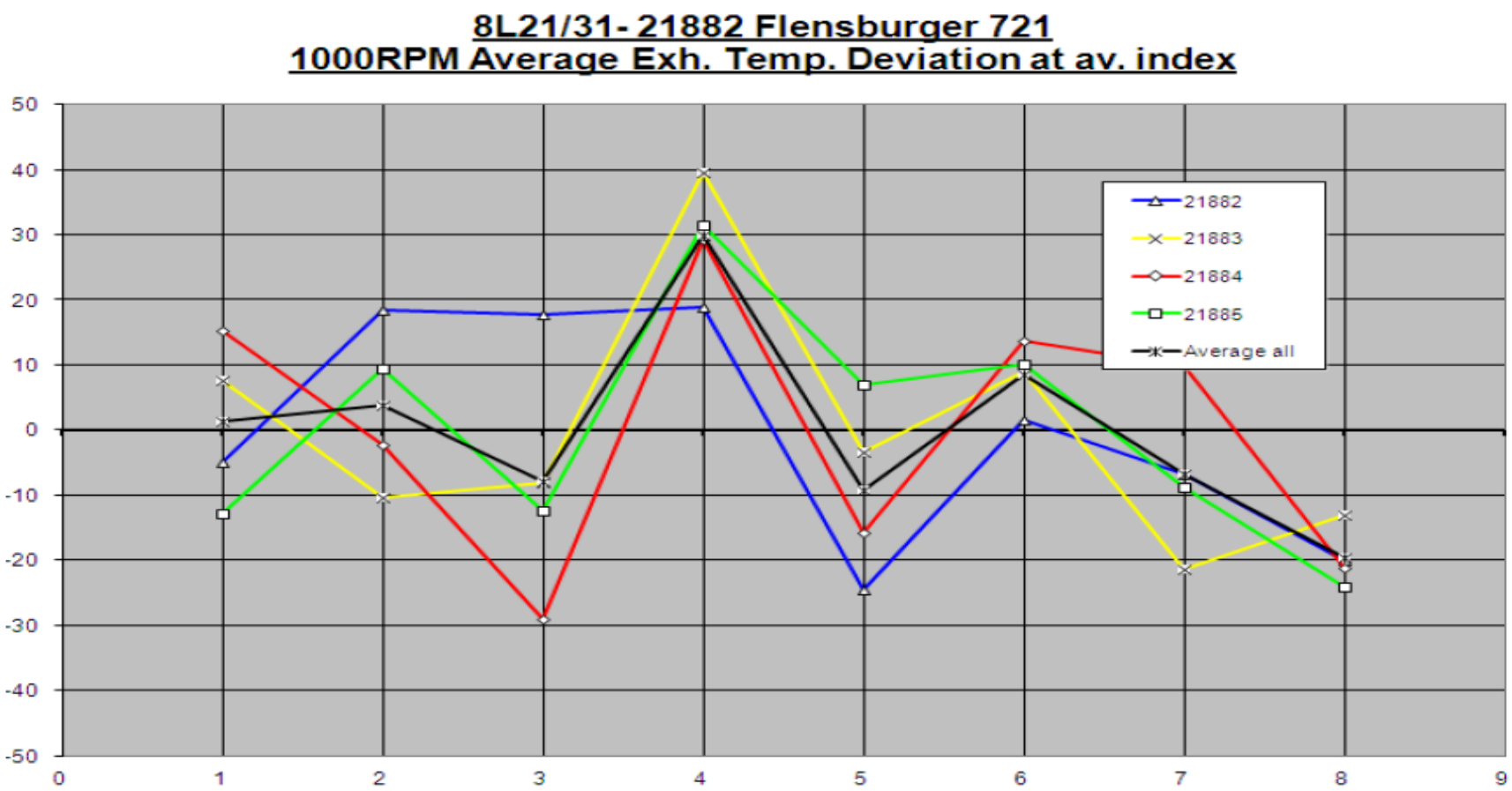
Exhaust gas temperatures

Measurement of exhaust gas temperature after cylinder is depending of sensor length in exhaust channel:



Exhaust gas temperatures

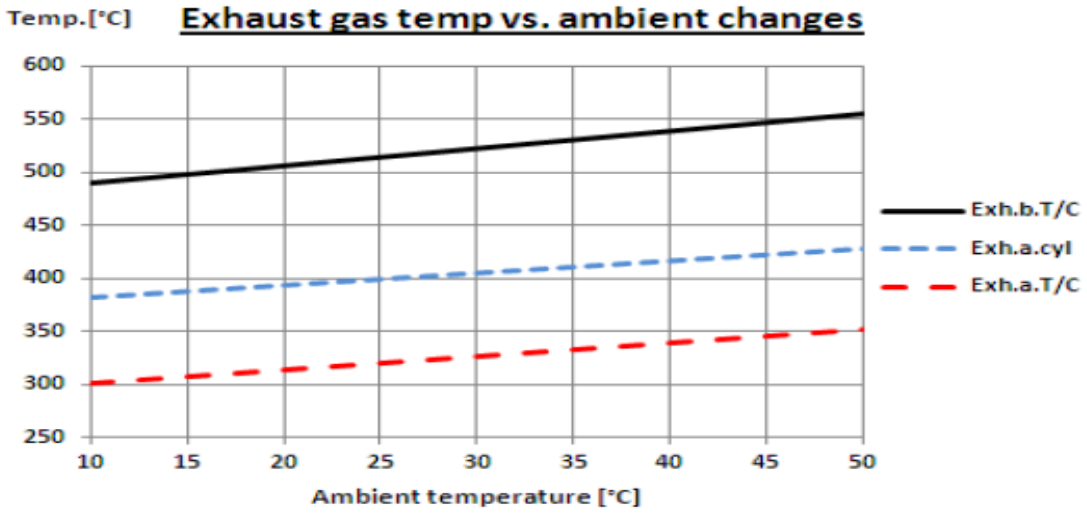
Exhaust temperature variations due to exhaust pipe design, firering order, speed and load.

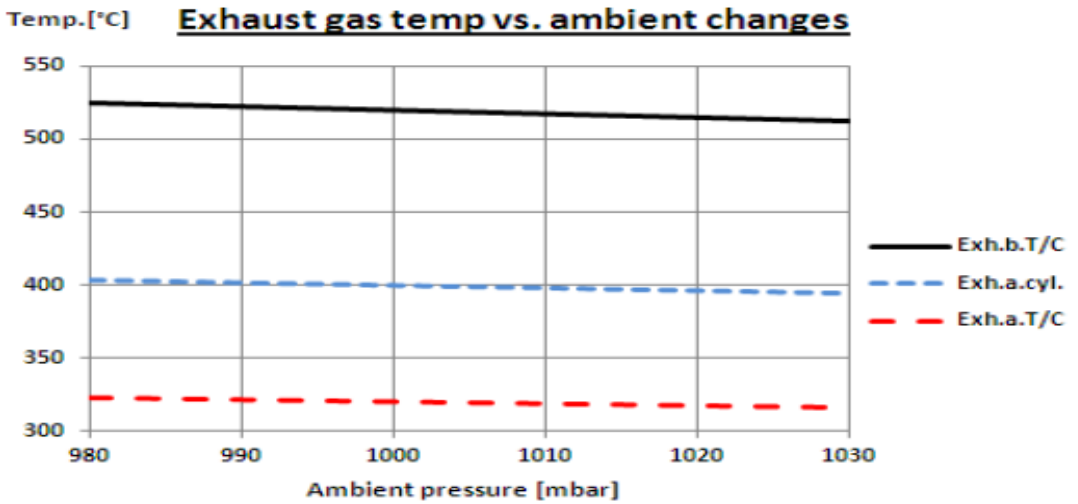


System based temperature variations has been eliminated with the "Equalizing function"

Exhaust gas temperatures

Exhaust temperature variations due to ambient temperature and pressure change.





Agenda

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