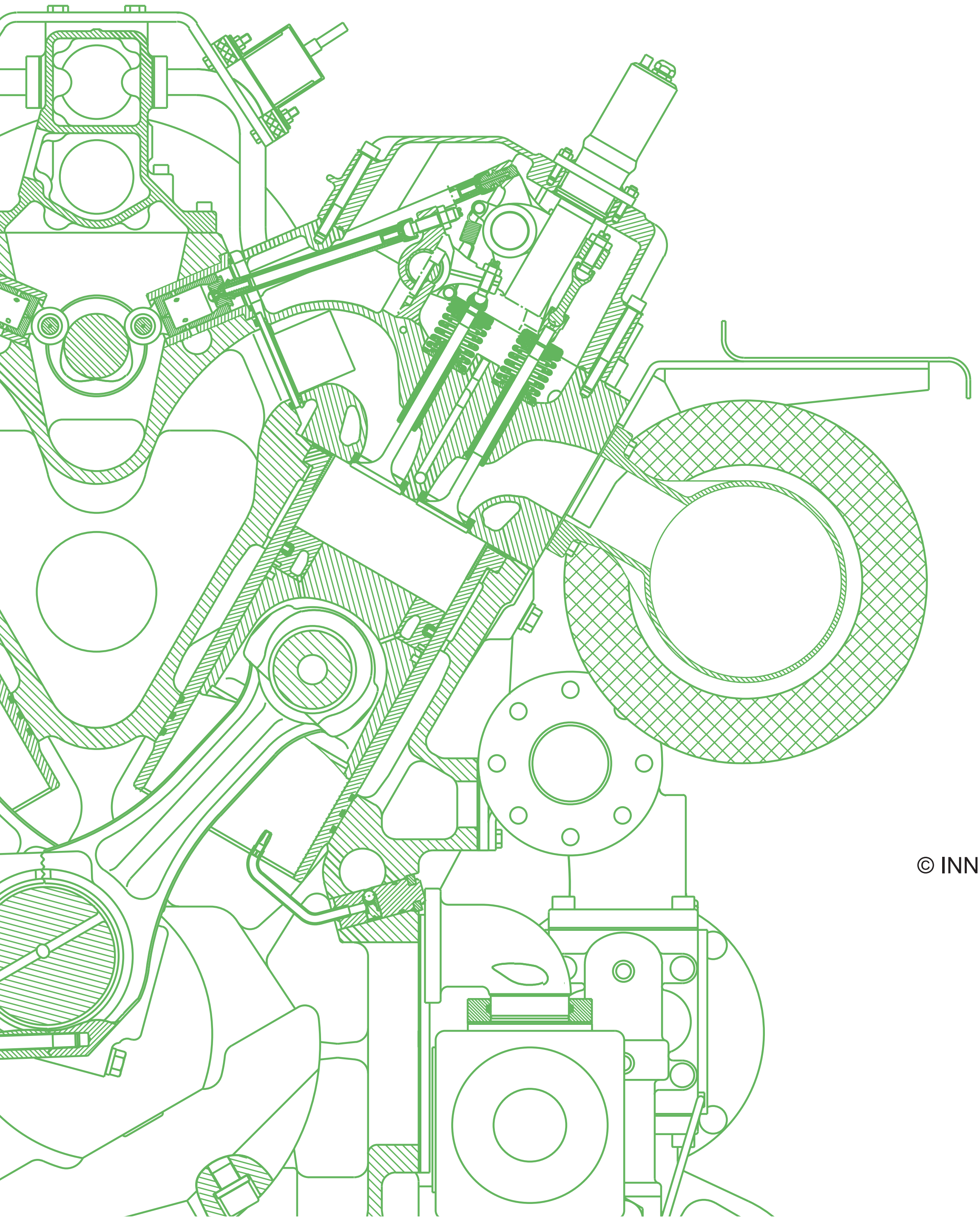
JENBACHER

TA 1503-0046

Technical Instruction

Engine adjustment instruction – type 6 engines (Diane XT)



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1 Scope

This Technical Instruction applies to Type 6 engines with DIA.NE XT.

2 Purpose

This Instruction describes the engine settings on the DIA.NE XT. They refer to standard applications in natural gas operation, and the parameter values may change for special gas applications. The parameters shown must be regarded as examples! Refer to the default parameter set and the technical diagram for the exact version-specific and customer-specific parameter sets.

3 Setting the fuel gas train

3.1 Gas train

Ensure that fuel gas of the required quality is available at the control system.

3.2 Basic setting for the gas prepressure controller

Before starting work on adjusting the controlled gas system supplied by INNIO Jenbacher GmbH & Co OG, close the shut-off valve before the gas prepressure controller and depressurise the gas pipe after the prepressure controller. If gas is to be blown off, you should always do so into the atmosphere through a hose. To connect the hose, you can thread it on to the screw plug at the solenoid valve inlet. A manometer is fitted to the controller outlet to enable you to check the gas pressure in controlled gas systems supplied by INNIO Jenbacher GmbH & Co OG.

Now loosen the pressure adjusting screw on the prepressure controller by turning it anti-clockwise until it stops (spring released).

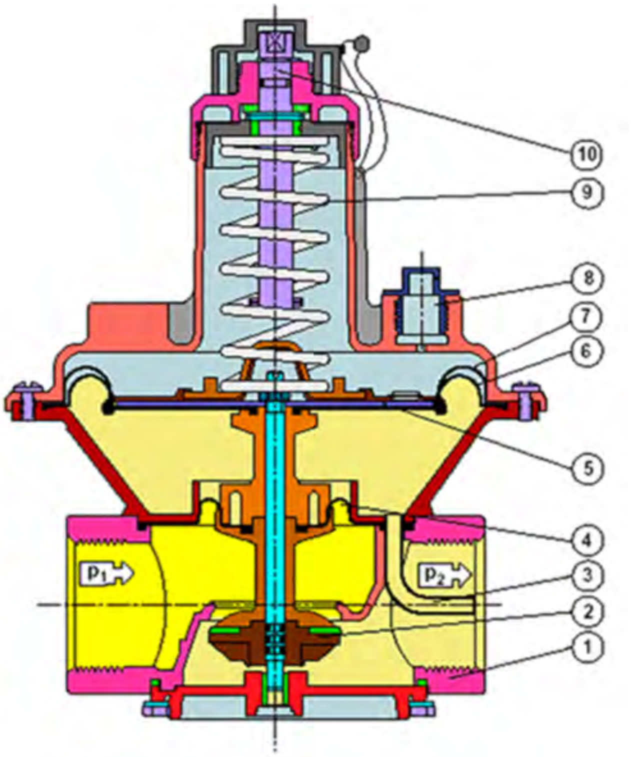
Caution! Controlled gas systems supplied by INNIO Jenbacher GmbH & Co OG with a nominal pressure of < 500 mbar are fitted with a blanking plate (orifice) between the ball valve and the prepressure controller, which closes off the controlled gas system when it is ready for shipping. The blank is used to protect against any unduly high pressures that may result when customers check the gas train for leaks.

When the gas train is put into operation, the orifice must be inserted in such a way that the passage between the ball valve and the prepressure controller is open.

Next, slowly open the shut-off valve before the prepressure controller again and use the adjusting screw on the prepressure controller to adjust the output pressure to the required pressure as stated on the technical diagram. For this no more gas should be vented to atmosphere. The only thing you should note is that if you have exceeded the required output pressure while adjusting, turning the adjusting screw back, without releasing the pressure, will no longer reduce the pressure!

Check the preset pressure once more when the engine is idling (flow pressure) and if necessary readjust it.

Pressure controller in working position:



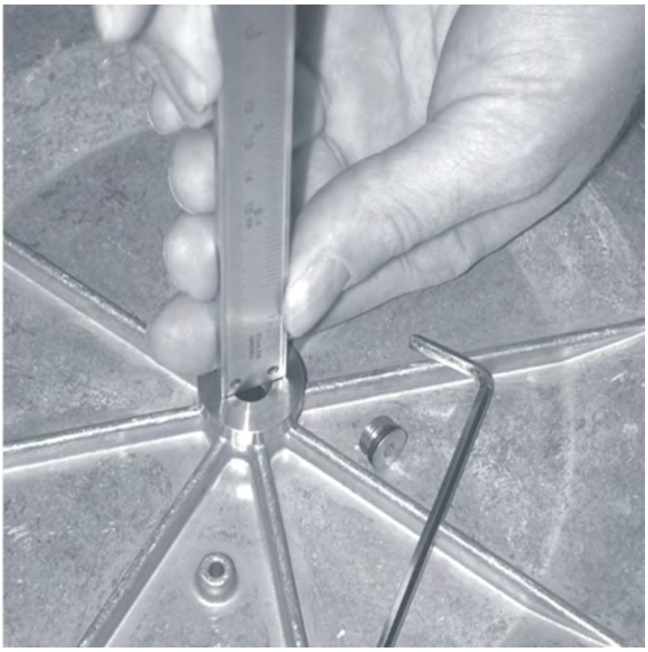
①	Housing	⑥	Working membrane
②	Control plate	⑦	Safety membrane
③	Pulse sensor, internal	⑧	Vent plug
④	Compensating membrane	⑨	Set point spring
⑤	Membrane plate	⑩	Adjustment mechanism

3.3 Basic setting for the zero pressure controller

This adjustment is carried out without feeding gas to the zero pressure controller.

The bottom cap of the zero pressure controller contains an opening which is closed by a hexagonal socket screw. After removing the hexagonal socket screw, use a depth gauge to measure the distance from the bottom cap to the centre of the controller.
With the gas solenoid valves closed, release the spring in the zero pressure controller (by turning the pressure adjusting screw anti-clockwise until it stops). You can then measure the distance from the bottom cap to the centre of the controller, turning the pressure adjusting screw clockwise until a measurement is produced which is 1 mm shorter than the previous measurement.

If the engine is idling, the gas pressure after the zero pressure controller should be +1 mm to +2 mm water column.



Once the hexagonal socket screw has been removed, the distance to the centre of the controller can be measured.

3.4 Testing the pressure transducer for booster pressure and precombustion chamber differential pressure

The requirement for this check is that the pressure conditions should be the same at the measuring points for the pressure sensors. For this reason, the prechamber gas rail has to be depressurised.

The boost pressure is displayed in DIA.NE and must be the same as the ambient pressure when the engine is at a standstill.

To check the prechamber gas pressure transducer, read off the prechamber differential pressure in DIA.NE. As the prechamber differential pressure displayed is a calculated value (prechamber gas pressure minus boost pressure) this value should be displayed as 0. Deviations of 10 mbar are possible on account of the manufacturers tolerances for the pressure transducers. If deviations exceed 10 mbar, the range of the pre-combustion chamber gas pressure transducer must be adjusted (parameter lists RESERVE / PRE CHAMBER PRESS. 4MA and PRE CHAMBER PRESS. 20MA).

4 Starting the engine for the first time and adjusting the LEANOX controller

4.1 Guidelines for adjusting the gas mixer positions

Before starting the engine for the first time, ensure that it is being supplied with fuel gas of the required quality.

All the set values below relate to applications requiring a constant gas quality (natural gas).

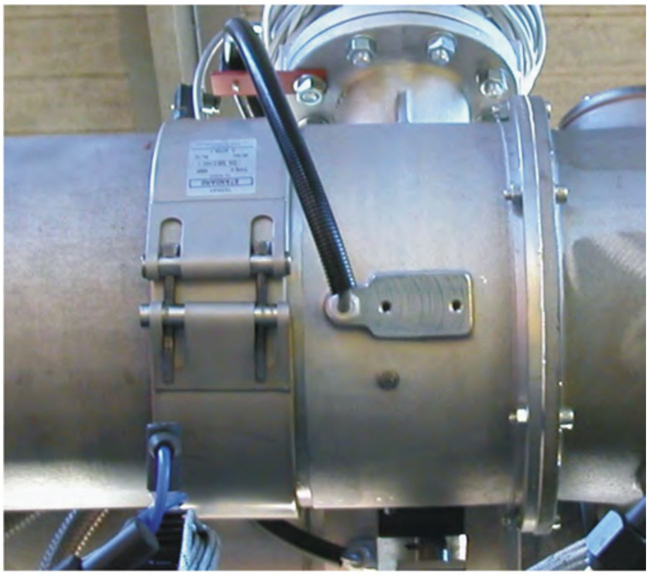
We know from experience that a somewhat richer gas mixer position is required to start a cold engine than is the case when the engine is warm. The oil temperature is used as the basis for the engine temperature.

Enter 2 points to define a straight-line adjustment. The oil temperature measured is restricted in the linear equation in the parameter list: GAS MIXER / GAS MIXER limited with OIL TEMP. MIN CURVE LIMIT or OIL TEMP. MAX. CURVE LIMIT

The oil temperature dependent gas mixer position applies until the engine speed is reached at which the idling speed controller (N controller) is activated. The latter occurs when the engine speed exceeds the SPEED UP value in the SPEED / LIMITS parameter list. After an adjustable delay in the parameter list: GAS MIXER / IDLE MODE LAMBDA / IDLE MODE L. (DELAY AFTER START) the idle mode lambda controller (LL controller) is activated.

The purpose of this controller is to keep the central throttle valve position (THROTTLE VALVE SET POSITION) in the optimum position. To this end, the gas mixer position is controlled via a PI controller (P-COMPONENT, I-COMPONENT) within the permissible adjustment range (GAS MIXER POS. CONTROLLING RANGE) relative to any gas mixer position determined by the oil temperature. The same controller is also active in speed-controlled mode after the transition from mains parallel operation to island operation. A delay between activation of the N controller and activation of the idle mode lambda controller (DELAY AFTER NET PARALLEL) is also provided in this case.

4.2 Adjusting the gas mixer starting and idling positions (GAS MIXER parameter list)



The values indicated relate to gas type 1.

New engines are run in at the test department in Jenbach. The gas mixer positions in the DIA.NE parameter lists are bench values and are generally values which can be used to start the engines on site, provided that they run on natural gas.

After every modification to the gas train and particularly to the zero pressure regulator (maintenance, adjustment, replacement, ...) the correct gas mixer parameters must be checked in accordance with the following remarks.

Before starting, switch off the synchronisation. If the engine is idling, check the ignition point.

At this stage, you should also check the precombustion chamber differential pressure. The precombustion chamber gas pressure should be approx. 50 mbar higher than the boost pressure.

If the engine is exhibiting erratic idling behaviour, switch the gas mixer to manual mode and try to make the engine run more smoothly by opening or closing the gas mixer.

Read and note the current throttle valve position in the CTRL 1 screen.

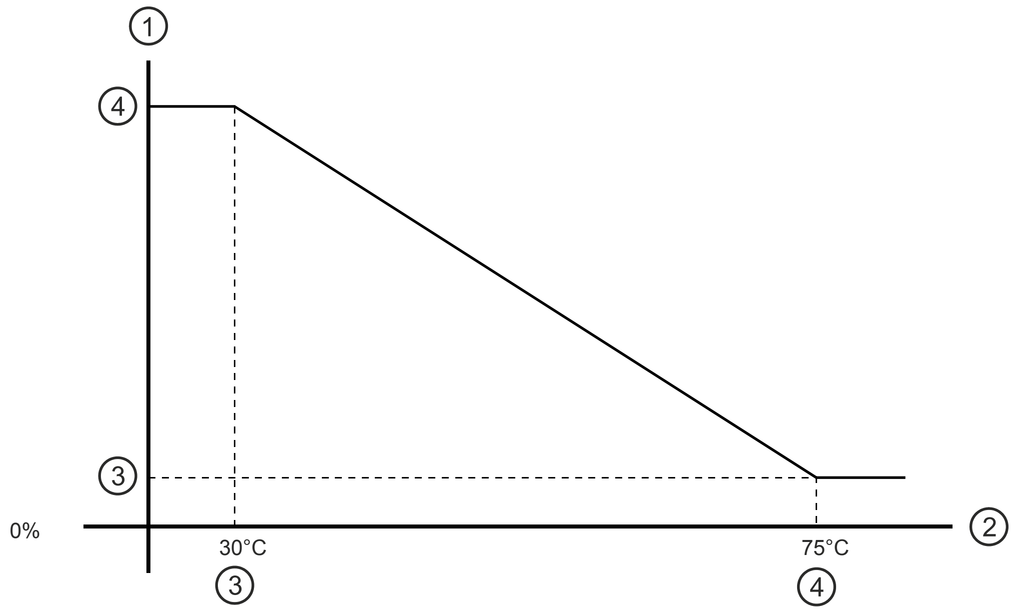
All you need to do to adjust the starting position defined by the oil temperature is to note the current gas mixer position, as the engine will have warmed up when idling in the course of adjustment operations.

Stop the engine again.

In the GAS MIXER / Gas type 1 parameter list, enter the calculated starting position under GAS MIXER POSITION POINT 2 (warm engine). Set OIL TEMPERATURE POINT 2 to 75°C (= oil temperature in steady condition at full load). First, adjust GAS MIXER POSITION POINT 1 to 2% greater than GAS MIXER POSITION POINT 2. Set OIL TEMPERATURE POINT 1 to 30°C (oil temperature at standstill). The optimum position of GAS MIXER POSITION POINT 1 must be determined in the course of commissioning and may be approx. 2% to 4% greater than GAS MIXER POSITION POINT 2.

Enter the optimum central throttle valve position previously noted in idling mode (engine running smoothly, good idling behaviour) in the GAS MIXER / IDLE MODE LAMBDA CONTROLLER / THROTTLE VALVE SET POSITION parameter list.

After synchronising, the throttle valve position can no longer be used to control the gas mixer position, as the throttle valve opens to achieve the preset engine output. For this reason, a GAS MIXER POSITION OFFSET NET PARALLEL OPERATION has been installed to position the gas mixer as defined by the oil temperature, plus the set offset. From experience we know that an offset value of 1% to 2% should be entered in the parameter list GAS MIXER / GAS TYPE 1 / GAS MIXER POSITION OFFSET NET PARALLEL OPERATION.



①	Gas mixer position	③	Point 1
②	Oil temperature	④	Point 2

Next, reset the gas mixer to automatic mode.
Enter the remaining parameters in the GAS MIXER parameter list.

Gas mixer parameter list

GAS MIXER	
CURVE LIMIT OIL TEMP. MIN.	30°C
CURVE LIMIT OIL TEMP. MAX.	100°C
GAS MIXER / IDLE MODE LAMBDA CONTROLLER	
DELAY AFTER START	4 s
DELAY AFTER NET PARALLEL, ISOL.OP.	10 s
P COMPONENT	3

Gas mixer parameter list

I COMPONENT	20
GAS MIXER / GAS TYPE	1
OIL TEMPERATURE POINT 1	30°C
GASMIXER POSITION POINT 1	50%
OIL TEMPERATURE POINT 2	75°C
GASMIXER POSITION POINT 2	48%
GAS MIXER POS. CONTROLLING RANGE	0%
GASMIXER POS. OFFSET NETPARALLEL	1%
GAS MIXER / IDLE MODE LAMBDA CONTROLLER / GAS TYPE 1	
THROTTLE VALVE SET POSITION	8%

The parameter values for GAS MIXER POSITION POINT 1, GAS MIXER POSITION POINT 2, THROTTLE VALVE SET POSITION and GAS MIXER POS. OFFSET NETPARALLEL in the above table should be regarded as sample values.

The table below shows the average values of 63 engine settings (gas mixer positions) in the field. Deviations by up to approx. 5% are possible as a result of slightly different zero pressure controller settings. The communication between the gas mixer and the zero pressure controller is an important factor. Combinations of “richer“ zero pressure controller settings and “richer“ gas mixer settings should be avoided.

612 Average value GM T1 Point 1	41.6 %
612 Average value GM T2 Point 2	37.0 %
616 Average value GM T1 Point 1	52.1 %
616 Average value GM T2 Point 2	48.7 %
620 Average value GM T1 Point 1	54.9 %
620 Average value GM T2 Point 2	51.6 %

LEANOX / COMPENSATION parameter list:

Set the ENGINE FRICTION POWER values to the following values.

Engine	ENGINE FRICTION POWER [kW]
J612	190
J616	250
J620	320

Caution! These values must not be changed.

4.3 Gas mixer

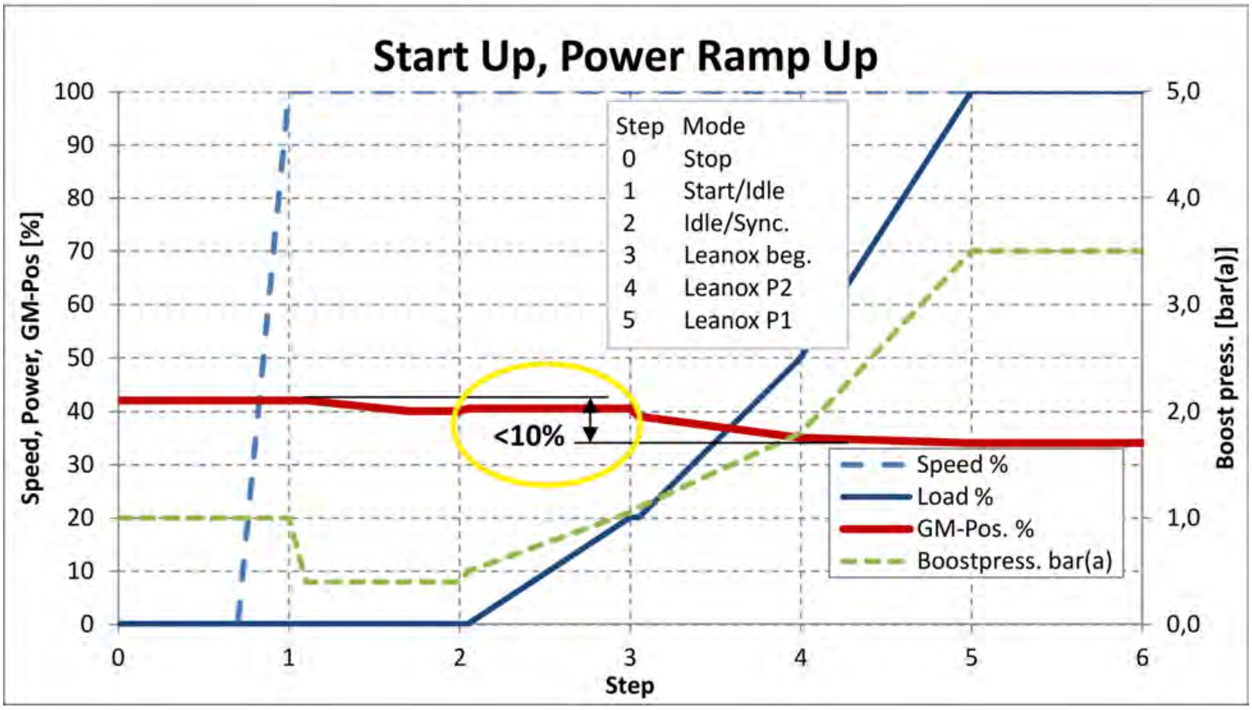
4.3.1 Scope

- Fuel gas: natural gas; methane number range 60 to 100
- Gas mixer type: Type 6 E venturi mixer (not for special gas mixers or TecJet gas proportioning valve)

- Type 6 E engines with aluminium or steel pistons (not applicable to E170 or E171 versions, or for camshafts with Miller timing)
- Power class (nominal mean pressure): 16 .... 20 bar

4.3.2 Gas mixer position range

The difference between the positions for engine starting and full load should not be more than a maximum of 15%.



⚠ WARNING	
	**Deflagration and exiting debris** If the differences between idling and full load are greater than 15%, the Leanox controller may become unstable at load application and the transition to Leanox controller operation and the mixture can become inadmissibly rich. This can result in undesirable instability or shutdowns and possible deflagration in the exhaust system, posing a risk of exiting debris. ➢ The difference between the positions for engine starting and full load must not be more than a maximum of 15%.

4.4 Boost pressure compensation for speed

This function is only required for variable-speed operation (e.g. mechanical drive) and can be activated in the LEANOX parameter list with SPEED COMPENSATION ACTIVE (0 = inactive; 1 = active).

4.5 Fine tuning of the gas mixer for starting and idling

Start the engine and, if necessary, optimise the parameters (for starting positions and idling behaviour) entered in the GAS MIXER parameter list.

4.6 Exhaust gas measurement below "Leanox active"

The correct setting for the mixture formation (gas mixer position and zero pressure regulator) can be checked by measuring the exhaust gas during idling or at a load point below the Leanox operating range. Typical characteristic values are set out in the Table below.

The following boundary conditions must be taken into account for this:

- Operating mode: manual (service level ≥ 30)
- Running period as short as possible (< 2 - 5 minutes)
- Cylinder exhaust gas temperatures below the limit value
- Pay attention to downstream systems and their plant-specific requirements (SCR catalytic converter, ...)

Measurement during idling

- Only permissible with aluminium pistons (compression ratio 11 or 12)
- Guideline boost pressure: 0.35 to 0.45 bar (a)

Exhaust gas measurement at 10 % load

- Operating mode: manual, stable operation under load below "Leanox active" required
- Applicable to aluminium and steel pistons
- Guideline boost pressure: 0.6 to 0.9 bar (a)

Typical exhaust gas measured values

Mode of operation	Boost pressure [bar (a)]	NOx ppm [ppm]	O2 % by vol [Vol%]	Nox mg [mg@5%O2]	Note
Idling mode	0.35 0.45	**40 150**	**4.0 8.0**	100 … 300	Misfires increase O2 content
10% load	0.6 …0.9	**100 200**	**5.0 …..8.0**	250 … 500	Misfires increase O2 content

4.7 Operation under load below LEANOX control operation

Set **POWER LEANOX CONTROLLER ACTIVE** (LEANOX / GAS TYPE 1 parameter list) to approx. 70% of P/nominal. In this way, the LEANOX controller does not become active immediately if the engine is synchronising.

The power setpoint should be set to approx. 30%.

Turn the synchronisation selector switch to the "Automatic" position.

When the engine has been synchronised at a power level below the LEANOX activation level, the gas mixer position is formed from the starting position defined by the oil temperature and a fixed offset (**GAS MIXER POSITION OFFSET NETPARALLEL OPERATION**).

Observe the power consumption of the engine after synchronisation, i.e. the power fluctuations should be as low as possible until the preset power setpoint is reached.

When the engine has reached 30% of its rated module load, switch the gas mixer to “manual mode“ and check the cylinder exhaust gas temperatures. The temperatures of all the cylinders should be approx. 450°C (± 30°C) (E version).

4.8 Leanox operation

Connect the exhaust gas test kit to the point provided in the exhaust gas line.

Increase the engine output gradually, checking the control of the NOx level (exhaust gas test kit) until the rated module load is reached.

Open or close the gas mixer to set the required NOx level (below the limit value specified in the technical diagram) and then click the SAVE 1 button to save the current parameters relevant to the LEANOX controller in full-load operation.

Reduce the engine output gradually, checking the NOx level, back to half load. Open or close the gas mixer to set the required NOx level and then click the SAVE 2 button. This saves the current parameters relevant to the LEANOX control system in half-load operation.

When you have successfully saved the LEANOX straights, check the control error “p2´err“ in the DIA NE LEANOX screen. The deviation should be as small as possible (approx. 0 – 10 mbar).

Next set the starting power of the LEANOX controller (engine type 612 = 300 kW, 616 = 400 kW, 620 = 500 kW) in the LEANOX / GAS TYPE 1 / POWER LEANOX CONTROLLER ACTIVE parameter list.

The gas mixers can now be switched to automatic mode. This switches the LEANOX control system to automatic mode.

4.9 Fine-tuning the Leanox straights

After saving the LEANOX straights, re-measure and document (e.g. print out) the exhaust-gas emissions (NOx) with the engine running at half-load. If the required NOx limit value is not reached, the engine is switched to full load and the measurement repeated.
The measurement must also be documented
with the engine at full load

If, for example, the required NOx limit value is exceeded at full load, the LEANOX straights can be corrected (fine-tuned):Leave the LEANOX controller operating in automatic mode with the engine at full load.

In the DIA.NE screen “Engine Controller“ / LEANOX / Point 1 (point for full load) increase the boost pressure “p2´mbar“ in small increments. The increments can be up to 20 mbar.

The control system copies the changed value immediately and begins to make the engine more lean. After about 2 minutes you can read off the NOx value on the exhaust gas test kit.

The measured NOx value should be approx. 20 - 30 mg/Nm³ below the required NOx value.

Next, print the values displayed on the exhaust gas test kit and switch the engine to half load. Normally, there will have been no changes in the exhaust gas emissions at half load. If however an adjustment is required, the same adjustment method is used as with the full load point, except that, following the adjustment, it is saved in the DIA.NE screen “Engine Controller“ / LEANOX / Point 2 (point for half load).

Caution: if the rated ignition point is changed or if there are changes in the gas quality, the exhaust gas emissions will also change.

Normally, the system corrects changes in the mixture temperature automatically.

4.10 Subsequent adjustment of the LEANOX controller

In addition to the adjustment instruction described in Section 3.7, it is possible to make a quick adjustment to any NOx deviations at full load or half load.

This type of adjustment is mostly used for engines which have been running for a prolonged period and whose exhaust gas emissions have to be re-measured and if necessary adjusted.

To adjust the LEANOX straights, switch the engine to full load and measure the exhaust gas emissions. If you find that NOx limit values have been exceeded, switch the gas mixer to “manual mode“ and set it to “rich“ or “lean“ until the desired NOx levels are reached. Then save the current values with “SAVE 1“.

Follow the same procedure at half load as well. If the NOx values are maintained at half load, there is no need to save the half-load point SAVE 2.

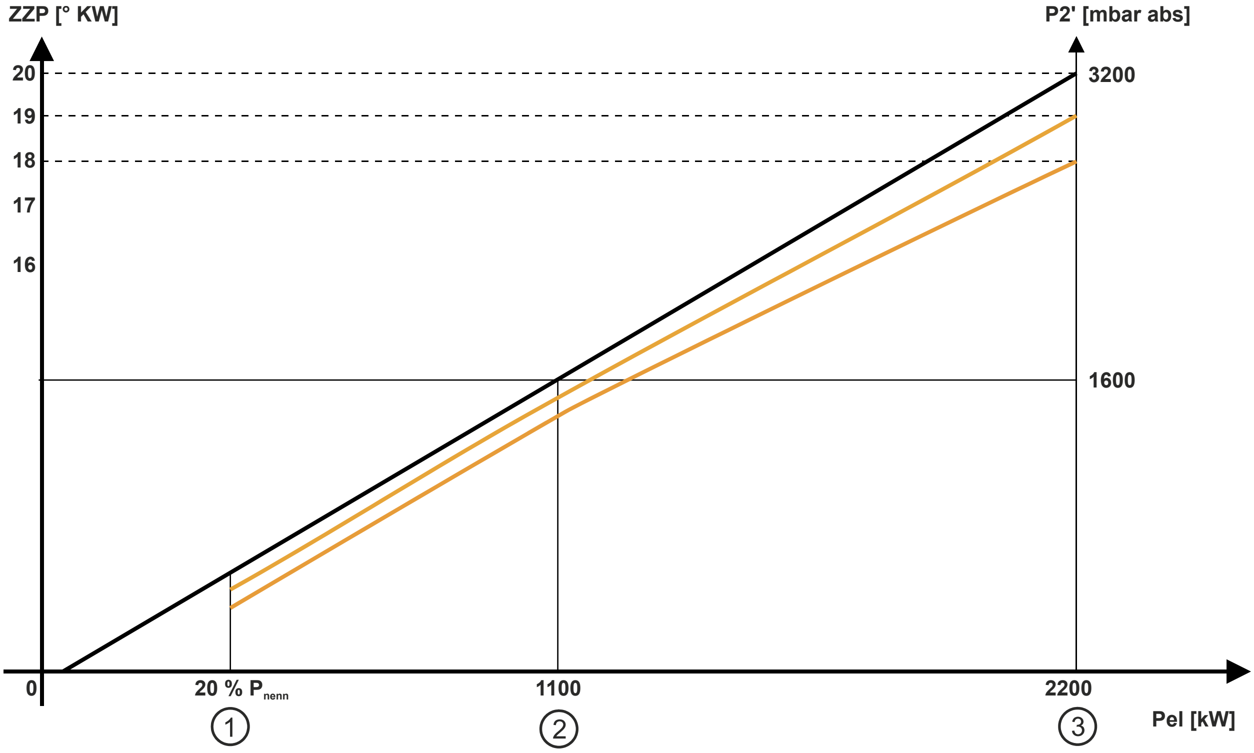
5 Additional functions for adjusting the LEANOX straights

5.1 Boost pressure compensation as a result of ignition point adjustment

The boost pressure compensation by means of IP adjustment is preset in natural gas engines and can be checked by adjusting the IP with the exhaust gas test kit. The IP boost pressure compensation can be activated or deactivated in the parameter list LEANOX / COMPENSATION / BOOST PRESSURE COMPENSATION VIA IP ACTIVE (0 = inactive; 1 = active).

POWER POINT 1 (IP)	xxxx	kWPel, engine at full load
BOOST PRESSURE CHANGE POINT 1 (IP)		-24 mbar / °IP
POWER POINT 2 (IP)	xxxx	kWPel, engine at half load
BOOST PRESSURE CHANGE POINT 2 (IP)		-13 mbar / °IP
START POWER (IP)	50	%

The boost pressure is changed at the specified power levels POWER POINT 1 (IP) and POWER POINT 2 (IP) exactly by the value in mbar / degrees IP entered in the parameter list BOOST PRESSURE CHANGE POINT 1 (IP) and BOOST PRESSURE CHANGE POINT 2 respectively. A linear interpolation is carried out between these two values. This applies between START POWER (IP) and POWER POINT 1 (IP) (engine output rating), where the value of BOOST PRESS. CHANGE PT. 2 (IP) applicable at START POWER (IP) is used.



①	Leanox start power
②	Half-load Power Point 2 Start Power (IP)
③	Full load Power Point 1

5.2 Additional boost pressure compensation as a result of mixture temperature

The boost pressure compensation resulting from a deviation in the mixture temperature is already taken into account in the Leanox algorithm. In special cases, this function provides an additional adjustment option.

This option should only be activated in special applications and only in consultation with Technology. The IP boost pressure compensation can be activated or deactivated in the LEANOX / COMPENSATION parameter list with the BOOST PRESSURE COMPENSATION VIA MIXTURE TEMP. ACTIVE parameters (0 = inactive; 1 = active).

POWER POINT 1 (MIXTURE TEMP)	xxxx	kW, engine at full load
BOOST PRESSURE CHANGE POINT. 1	xxxx	mbar / °C
POWER POINT 2 (MIXTURE TEMP)	xxxx	kW, engine at half load
BOOST PRESSURE CHANGE POINT. 2	xxxx	mbar / °C
START POWER (IMIXTURE TEMP)	50	%

The boost pressure is changed at the specified power levels POWER POINT 1 (MIXTURE TEMP) and POWERPOINT 2 (MIXTURE TEMP) exactly by BOOST PRESSURE CHANGE POINT 1 and BOOST PRESSURE CHANGE POINT 2 in mbar / degrees of mixture temperature. A linear interpolation is carried out between them. The interpolated values apply between START POWER (IMIXTURE TEMP) and the engine output rating. Below this, the value of BOOST PRESSURE CHANGE POINT 2 applicable at START POWER (MIXTURE TEMP) is used.

5.3 Reducing the ignition point when the engine is at full load

A situation may arise at increased engine intake air temperatures where the engine fails to reach its full output. A later ignition point may improve this situation as the turbine in the turbocharger will then be supplied with more energy.
Ignition point reduction can be activated or deactivated in the parameter list **IGNITION** / IP ADAPTION VIA TURBO BYPASS ACTIVE (0 = inactive; 1 = active).

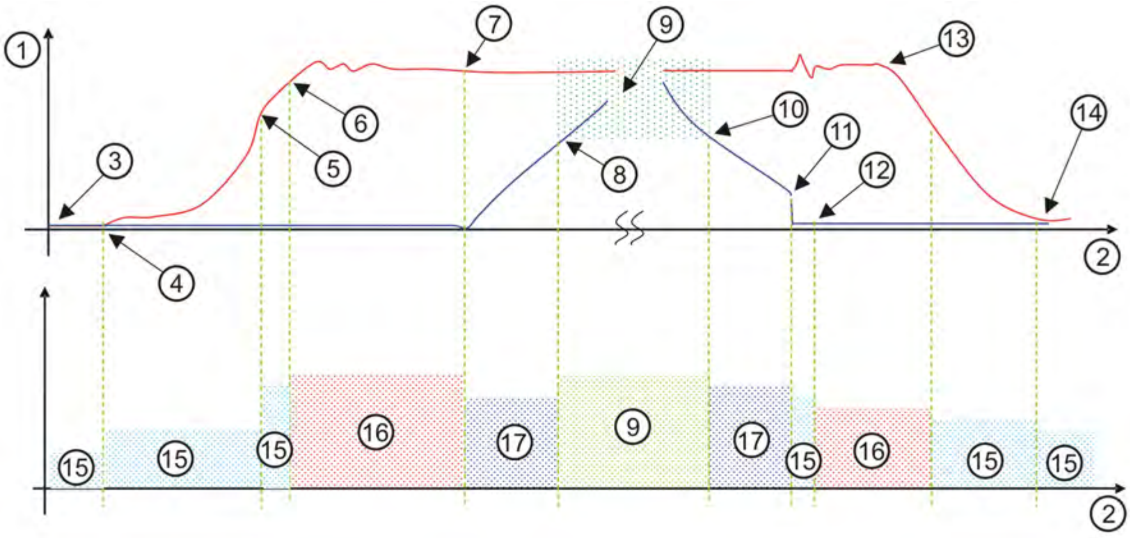
Ignition point reduction starts when the turbobypass has reached a value of 15% with the engine at full load.

This value can be adjusted in the parameter list IGNITION /

TURBO BYPASS POSITION 15%

The minimum permitted IP must be entered in the parameter list **ANTIKNOCK / MINIMUM IP GAS TYPE xx**.

5.4 Summary graph



①	Speed power output
②	Time
③	Engine standstill
④	Engine start
⑤	Engine run-up
⑥	Engine start-up plus delay T1
⑦	Mains parallel operation
⑧	Leanox - start delay
⑨	Leanox - operation
⑩	Leanox - stop
⑪	Idling, generator switch off
⑫	Generator switch off plus delay T2
⑬	Switching-off phase
⑭	Engine standstill
⑮	Gas mixer position is oil temperature-dependent
⑯	Oil temperature and throttle valve dependent gas mixer position controller
⑰	Oil temperature dependent gas mixer position + offset (set value)

6 Knock control system KLS 98

6.1 Knock control system in general

The general function of the knock control system is described in Technical Instruction 1400 – 0154.

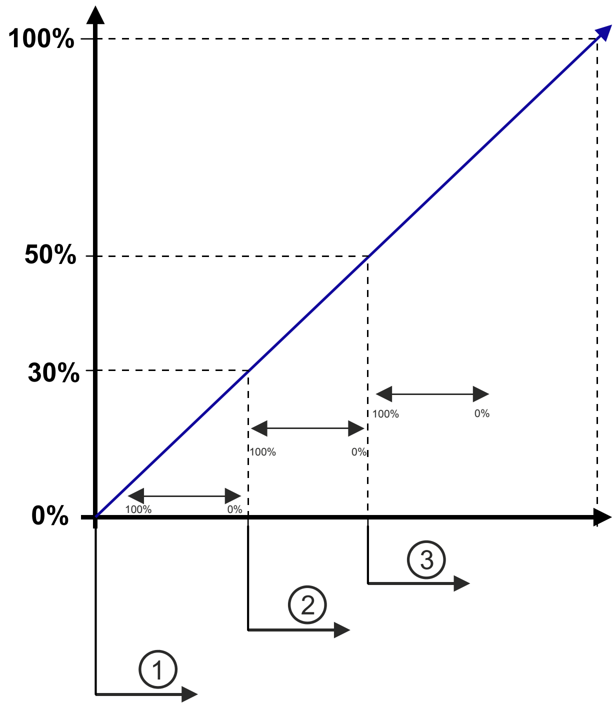
The parameter values listed below are used as guide values for Type 6 natural gas engines.

ANTIKNOCK		
KNOCK MONITORING ACTIVATION POWER	400 kW	J 612

KNOCK MONITORING ACTIVATION POWER	500 kW	J 616
KNOCK MONITORING ACTIVATION POWER	700 kW	J 620
KNOCK MONITORING ACTIVATION POWER HYSTERESIS	5 %	
	Mixture temperature control	
	without	with
IP REDUCTION START	0 %	0 %
MIXTURE TEMPERATURE REDUCTION START	100 %	30 %
POWER REDUCTION START	50 %	50 %
IP AMPLIFICATION FACTOR	2.5	2.5
MIXTURE AMPLIFICATION FACTOR	5	5
POWER AMPLIFICATION FACTOR	2.5	2.5
MIXTURE TEMPERATURE REDUCTION MAXIMUM	10° C	10° C
MINIMUM IP GAS TYPE xx	12° CA	12° CA
DECREASE INTEGRATION TIME	25 s	25 s
INCREASE INTEGRATION TIME	2500 s	2500 s
ANTIKNOCK / KLS 98		
RESET IMPULSE POSITION	-204° CA	
START ANGLE FOR KNOCKING DETECTION RANGE	0° CA	
ANGLE RANGE FOR KNOCK DETECTION	45° CA	
START ANGLE FOR VALVE NOISE DETECTION RANGE	50° CA	
ANGLE RANGE FOR VALVE NOISE DETECTION	660° CA	
MEASUREMENT SIGNAL FAILURE LIMIT	50 mV (from KLS version 1.38 = 30 mV)	
KNOCK LIMIT	1000 mV (from KLS version 1.38 = 750 mV)	
VALVE NOISE LIMIT	8000 mV	
GLOBAL IP ADJUSTMENT	(1 = Global; 0 = Selective)	
OPTION SELECTION CYLINDER xx	(0 = light/piezo off; 1 = piezo on; 2 = light on; 3 = light/piezo on)	

Diagram showing knock reductions:

Integrator threshold



①	Start of power reduction from 100% Prated to 50% Prated
②	Start of mixture temperature reduction (if any). Nominal mixture temperature minus MIXTURE REDUCTION MAXIMUM in the recipe list.
③	Start of ignition point reduction. Nominal ignition point up to IP MINIMUM IP GAS TYPExx in the parameter list.

The integrator rises when knocking occurs (signal > valve noise limit) and slowly falls again when there is no knocking.

It rises faster when knocking is more intensive than when knocking is lighter.

For example:

At 0% integrator threshold, ignition point reduction begins.

At 30% integrator threshold, mixture temperature reduction begins.

At 50% integrator threshold, power reduction begins.

At 50% integrator threshold, the engine trips due to knock limit.

7 Revision code

Revision history

Index	**Date**	**Description / Revision summary**	**Expert** *Auditor*
3	11.04.2019	GE durch INNIO ersetzt / GE replaced by INNIO	**Opoku** *Pichler R.*
2	30.10.2015	Gasmischer hinzugefügt (4.3), Reihenfolge angepasst, 4.2, 4.3.2, 4.6 / Gas mixer added (4.3), order adapted, 4.2, 4.3.2, 4.6	**Schaumberger H.** **Rangger A.** **Lopez Gutierrez F.** **Mader M.** *Boewing R.*

Revision history

1	11.08.2010	Umstellung auf CMS / Change to Content Management System ersetzt / replaced Index: -1	**Bilek** *Rangger Alfred*