Content Page

E 1 Machine data

- **Main data for design and operation**

				Design Values		
		Units		**Guarantee**	**Operating point**	**Operating point**
Operating point/ measurement No.						
• **Medium handled**						
Gas composition						
Percent by volume						
Component	kg/kmol					
Nitrogen N_2	28.02	%		100		
SO_2						
NH_3						
HCL						
H_2S						
Relative humidity		%		0		

- **Operating points for compressor 14 - 2275**

	Units		Design values	Min.	Max.
Operating point /measurement No.			**Guarantee**		
Date/time					
• **Compressor data**					
Volumetric flow/normal state	Nm^3/h	X	**14 900**	13 000	16 400
Actual inlet flow	m^3/h		**15 563**	13 844	16 677
Inlet mass flow	kg/h		**18 615**	16 236	20 493
Suction pressure at battery limit Stage 1	bar(a) bar(g)	X	**1.05**	1.03	1.05
Inlet temperature at battery limit Stage 1	°C		**22**	22	22
Gas pressure at battery limit discharge side	bar(a) bar(g)	X	**7.3**	7.3	7.3
Discharge temperature downstream after cooler	°C		**25**	24	26

- **Operating points for compressor 14 - 2276**

	Units		Design values	Min.	Max.
Operating point /measurement No.					
Date/time					
• **Compressor data**					
Volumetric flow/normal state	Nm^3/h	X	14 900	12 550	15 200
Actual inlet flow	m^3/h		16 305	14 004	16 635
Inlet mass flow	kg/h		18 620	15 678	18 995
Suction pressure at battery limit Stage 1	bar(a) bar(g)	X	1.05	1.03	1.05
Inlet temperature at battery limit Stage 1	°C		36	36	36
Gas pressure at battery limit discharge side	bar(a) bar(g)	X	7.3	7.3	7.3
Discharge temperature downstream after cooler	°C		42	45	42

X These values will be measured/stated alternatively. Please observe units.

	Units		Design Values		
Operating point/ measurement No.					
Driving shaft speed	min^{-1}		2 980		

- **Lubricating system**

Oil pressure downstream of filter/before compressor	bar(g)		max 2.0		
Oil temp. downstream of compressor	°C		48		
Oil throughput	ltr./min		approx. 380		

- **Gas cooler**

Waterpressure in the system	bar(g)		design 2.5		
Watertemperature in the system	°C		max 37 °C design 20 °C		
Total water throughput (Gas cooler, Oil cooler)	m³/h		130		
max. allowable increasing of watertemp.	K		10		

- **Conversion**
  - 1 bar = 0.1 MPa
  - 1 MPa = 10 bar
  - 1 bar = 100 KPa
  - 1 KPa = 0.01 bar

	Units		Design Values		
Operating point/ measurement No.			**Guarantee**		
● Sound level of compressor plant *)					
a) with driver					
Mean acoustic power $\overline{L}_{WA}$	dB(A)		117		
Emission level $\overline{L}_{pA}$ at work place, undamped	dB(A)		96		
Emission level $\overline{L}_{pA}$ at work place, damped	dB(A)				
b) without driver					
Mean acoustic power $\overline{L}_{WA}$	dB(A)				
Emission level $\overline{L}_{pA}$ at work place, undamped	dB(A)				
Emission level $\overline{L}_{pA}$ at work place, damped	dB(A)				

X: Values marked X will be measured/stated alternatively. Please observe dimensions.

*) Distance to measuring surface: 1 m
Sound data tolerance: ± 2 dB

E 1.1 Mechanical/thermodynamic factory test run

Quality Assurance of the final product is defined as functional test of the individual machine in the framework of a mechanical test run and/or a thermodynamical performance test including a mechanical test run depending on the individual order requirements.

E 1.1.1 Mechanical test run

As a rule, mechanical test runs are carried out without testing performance data; in the course of compressor testing, the electric motor of the test shop is employed as driver, unless the original driving unit is to be tested concurrently.

In the course of this test run, which is either carried out in the test shop or in our workshop for final assembly, the mechanical behaviour of the individual machine is evaluated under normal operating speed conditions.

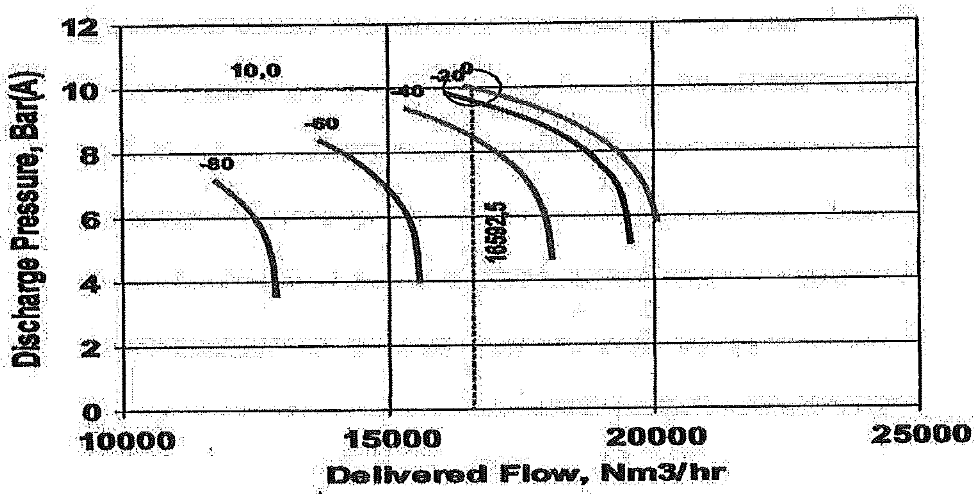
E 1.1.2 Performance curves

Design Point
Atlas Copco
PASELSizing Program, Version 1.2.19, Database Version 3,37

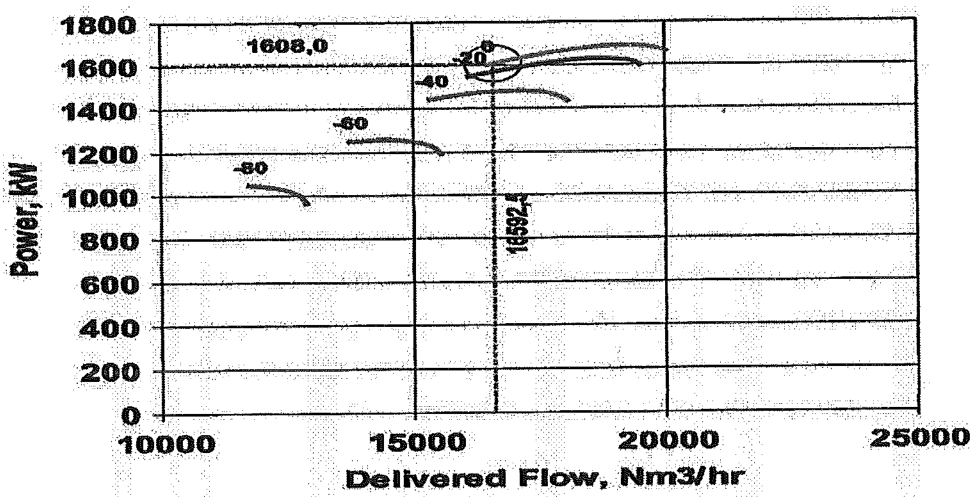
Curve shape and surge margin not binding. Curves calculated at battery limits.

Customer:	Messer /AL - Kosice	Model:	HL8-4-75
Reference:	04-075 Case A Design	Date:	12.01.2005
Customer conditions		**Reference conditions**	
Barometric pressure	1,170 Bar(A)	Pressure	1,013 Bar(A)
Inlet Pressure drop	0,005 Bar(A)	Temperature	0,0 Deg C
Inlet temperature	22,0 Deg C	Relative humidity	0 %
Relative humidity	0 %	**Tolerance**	
Coolant temperature	16,0 Deg C	Flow +/-	0 %
Driver Speed	2980 rpm	Specific Power +/-	0 %

Discharge Pressure vs Flow



Power vs Flow



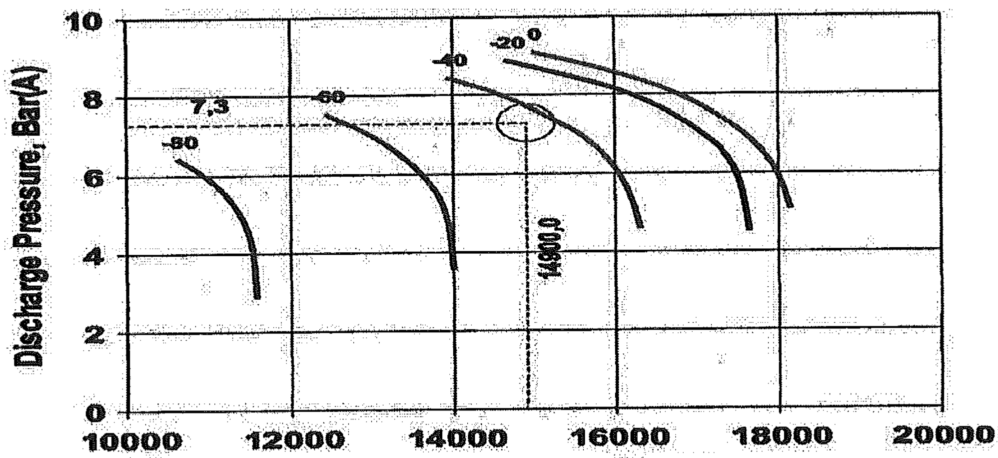
Garantie

Performance at Specified Flow
Atlas Copco
PASELSizing Program, Version 1.2.19, Database Version 3,37

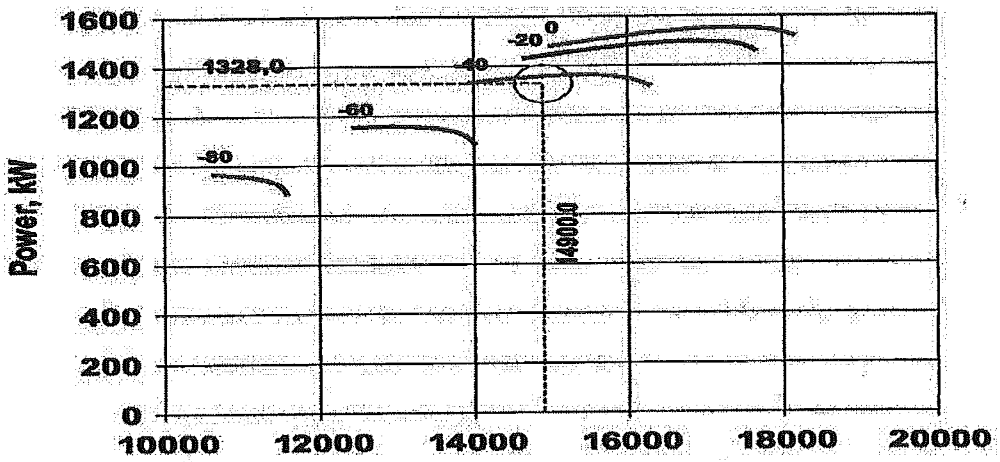
Curve shape and surge margin not binding. Curves calculated at battery limits.

Customer:	Messer /AL - Kosice	Model:	HL8-4-75
Reference:	04-075 Case A Design	Date:	09.12.2004
Customer conditions		**Reference conditions**	
Barometric pressure	1,050 Bar(A)	Pressure	1,013 Bar(A)
Inlet Pressure drop	0,005 Bar(A)	Temperature	0,0 Deg C
Inlet temperature	22,0 Deg C	Relative humidity	0 %
Relative humidity	0 %	**Tolerance**	
Coolant temperature	16,0 Deg C	Flow +/-	0 %
Driver Speed	2980 rpm	Specific Power +/-	0 %

Discharge Pressure vs Flow



Power vs Flow



Performance at Specified Flow
Atlas Copco
PASELSizing Program, Version 1.2.19, Database Version 3,37

Curve shape and surge margin not binding. Curves calculated at battery limits.

Customer:	Messer /AL - Kosice	Model:	HL8-4-75
Reference:	04-075 Case A Min	Date:	09.12.2004

Customer conditions

Barometric pressure	1,030 Bar(A)
Inlet Pressure drop	0,005 Bar(A)
Inlet temperature	22,0 Deg C
Relative humidity	0 %
Coolant temperature	16,0 Deg C
Driver Speed	2980 rpm

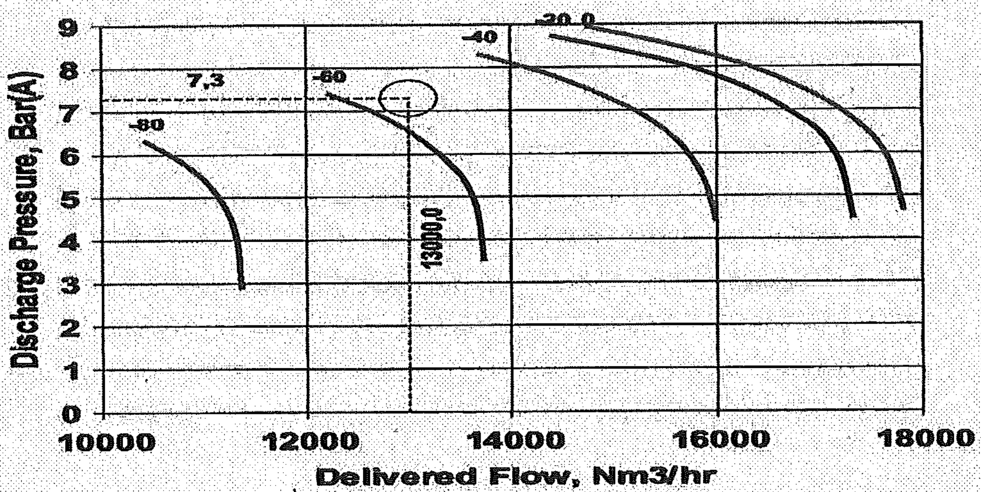
Reference conditions

Pressure	1,013 Bar(A)
Temperature	0,0 Deg C
Relative humidity	0 %

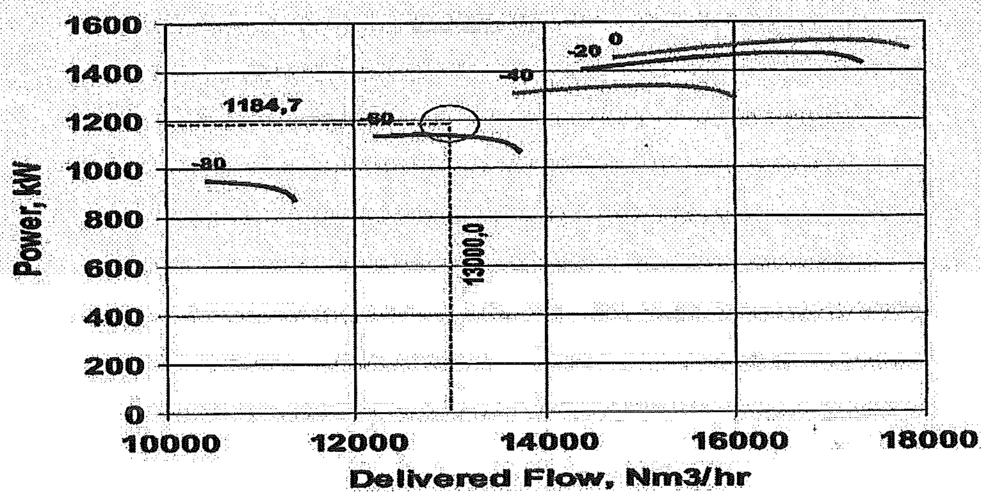
Tolerance

Flow +/-	0 %
Specific Power +/-	0 %

Discharge Pressure vs Flow



Power vs Flow

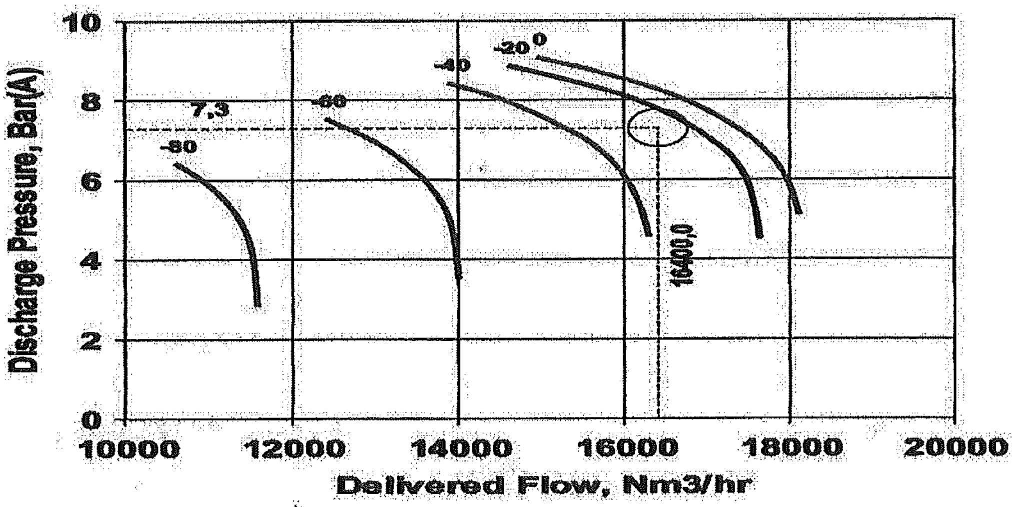


Performance at Specified Flow
Atlas Copco
PASELSizing Program, Version 1.2.19, Database Version 3,37

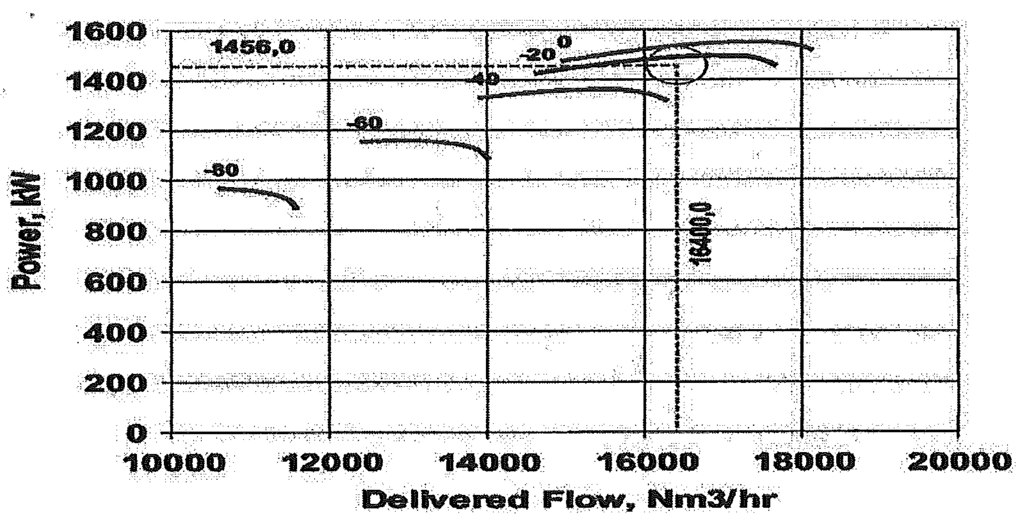
Curve shape and surge margin not binding. Curves calculated at battery limits.

Customer:	Messer /AL - Kosice	Model:	HL8-4-75
Reference:	04-075 Case A Max	Date:	09.12.2004
Customer conditions		**Reference conditions**	
Barometric pressure	1,050 Bar(A)	Pressure	1,013 Bar(A)
Inlet Pressure drop	0,005 Bar(A)	Temperature	0,0 Deg C
Inlet temperature	22,0 Deg C	Relative humidity	0 %
Relative humidity	0 %	**Tolerance**	
Coolant temperature	16,0 Deg C	Flow +/-	0 %
Driver Speed	2980 rpm	Specific Power +/-	0 %

Discharge Pressure vs Flow



Power vs Flow

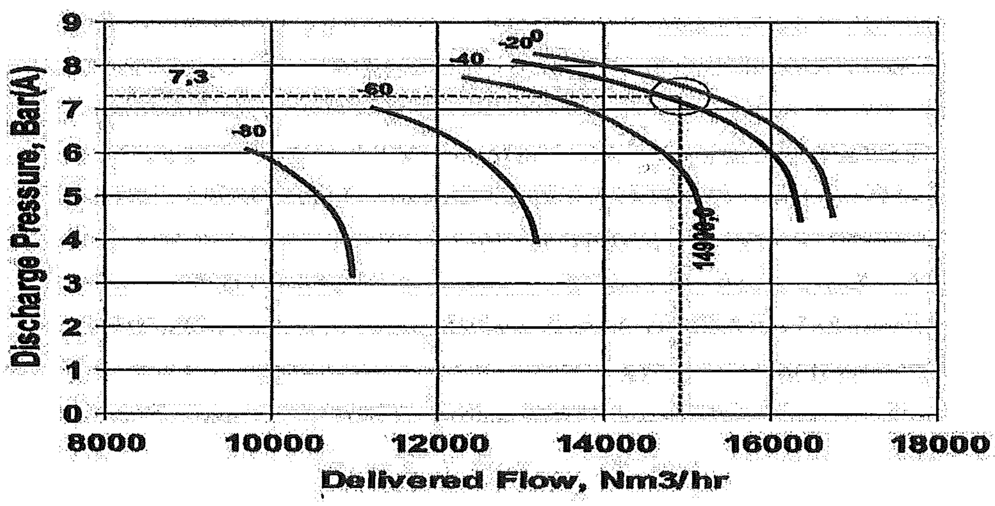


Performance at Specified Flow
Atlas Copco
PASELSizing Program, Version 1.2.19, Database Version 3,37

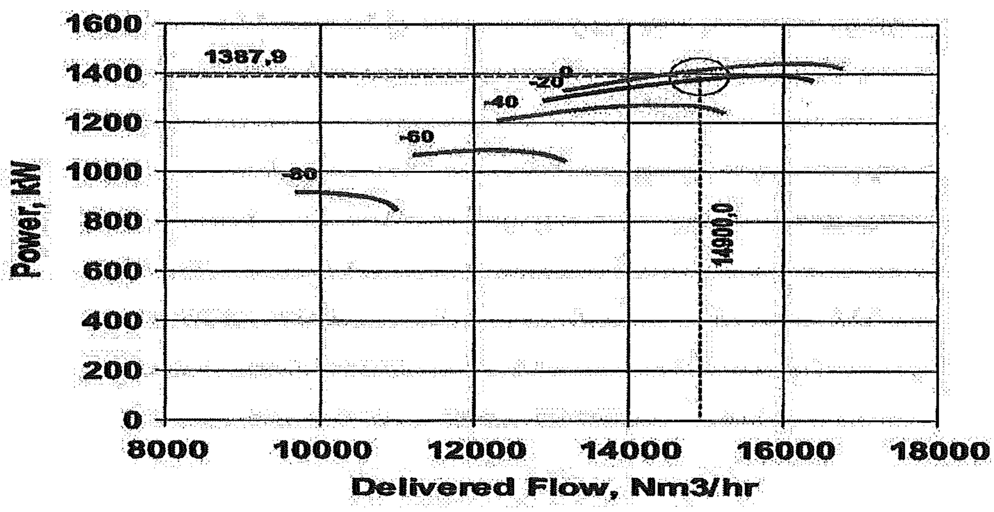
Curve shape and surge margin not binding. Curves calculated at battery limits.

Customer:	Messer /AL - Kosice	Model:	HL8-4-75
Reference:	04-075 Case B Design	Date:	09.12.2004
Customer conditions		**Reference conditions**	
Barometric pressure	1,050 Bar(A)	Pressure	1,013 Bar(A)
Inlet Pressure drop	0,005 Bar(A)	Temperature	0,0 Deg C
Inlet temperature	36,0 Deg C	Relative humidity	0 %
Relative humidity	0 %	**Tolerance**	
Coolant temperature	37,0 Deg C	Flow +/-	0 %
Driver Speed	2980 rpm	Specific Power +/-	0 %

Discharge Pressure vs Flow



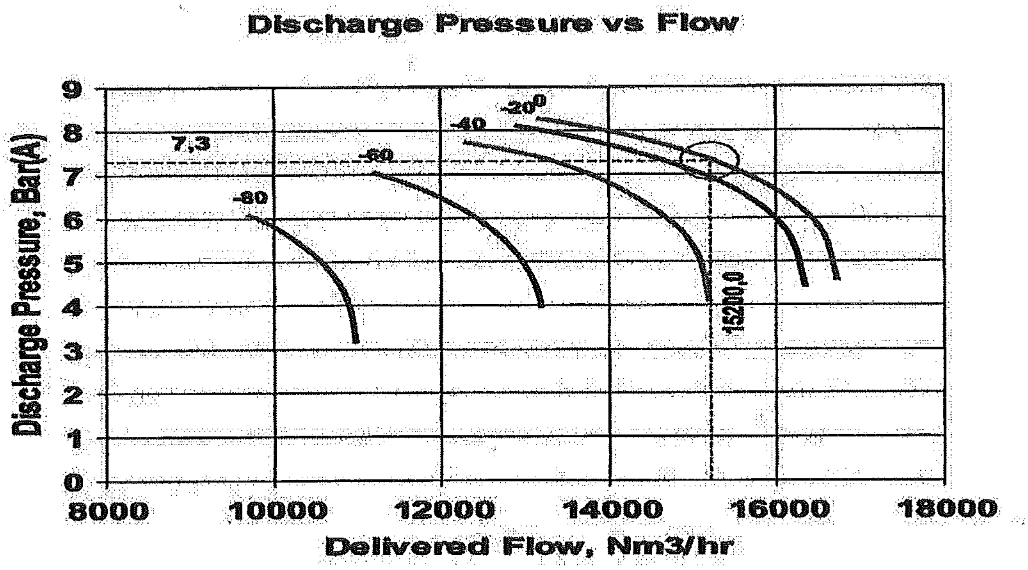
Power vs Flow

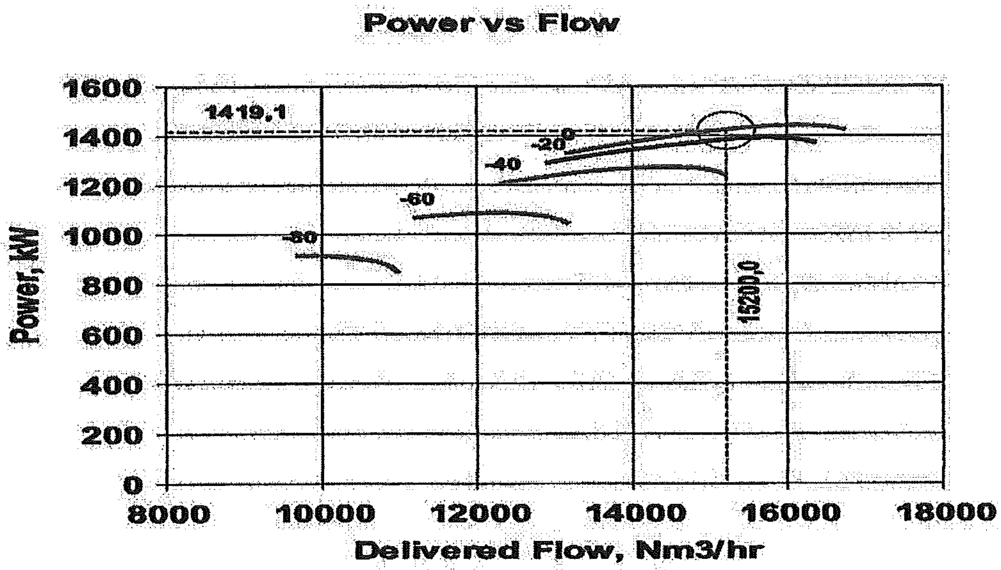


Performance at Specified Flow
Atlas Copco
PASELSizing Program, Version 1.2.19, Database Version 3,37

Curve shape and surge margin not binding. Curves calculated at battery limits.

Customer:	Messer /AL - Kosice	Model:	HL8-4-75
Reference:	04-075 Case B Max	Date:	09.12.2004
Customer conditions		**Reference conditions**	
Barometric pressure	1,050 Bar(A)	Pressure	1,013 Bar(A)
Inlet Pressure drop	0,005 Bar(A)	Temperature	0,0 Deg C
Inlet temperature	36,0 Deg C	Relative humidity	0 %
Relative humidity	0 %	**Tolerance**	
Coolant temperature	37,0 Deg C	Flow +/-	0 %
Driver Speed	2980 rpm	Specific Power +/-	0 %





E 2 Compressor execution

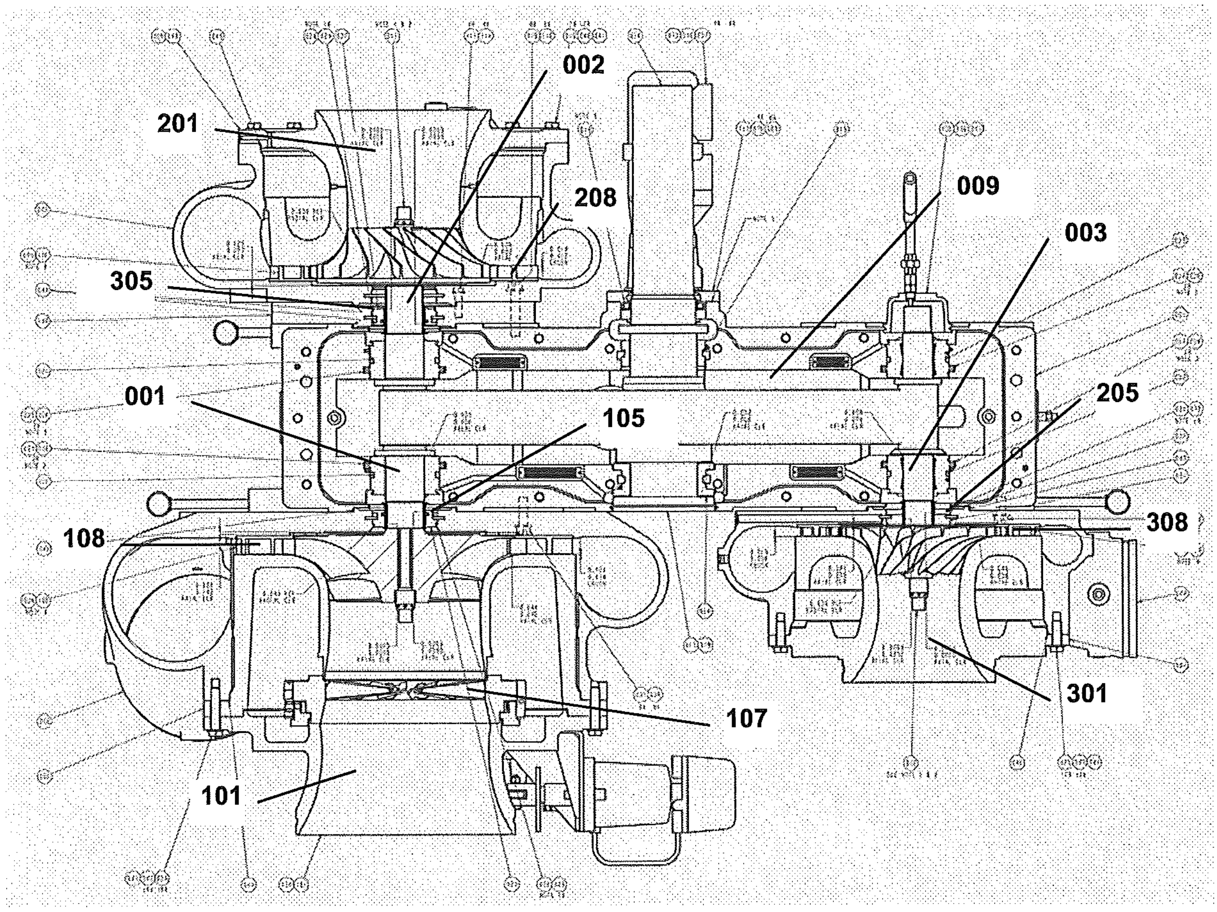
Centrifugal compressors are integrally geared radial compressors, gears are designed as single helical spur type with horizontally split gearbox.

Impellers are arranged in an overhung position which allows aerodynamically favourable axial admission of the gas being compressed.

The gas taken in is accelerated in the suction nozzle and impeller; it is here and in the subsequent diffuser that the kinetic energy generated in the impellers is converted to potential energy. The resulting pressure increase is effected in impeller, diffuser, and spiral casing.

For machine cross section, refer to the annex.

Made from drawing no.: 1320 102 811



00Y	Pinion shaft	X01	Suction housing	X = Stage number
009	Gear	X07	Inlet guide vane	Y = Rotor number
005	Shaft seal	X08	Diffuser guide vane	

E 2.1 Casing

The casings of centrifugal compressors are designed and constructed to considerations of fluid flow and mechanical strength.

Standardized components are:

- **Spiral casing**

Spiral casing (concurrently rear wall of bladeless parallelwalled diffuser), the cross section of which expands in sense of impeller rotation. The spiral with tangential discharge nozzle can be adjusted to the conduct of piping corresponding to bolt distribution in the planning phase. The spiral rear wall with snug fit and threaded hole circle will be bolted to the gear half flange.

- **Suction casing**

The suction casings for open impellers are also designed as suction nozzle with a part of it formed in line with the impeller contour and subsequent diffuser front wall. All parts of the compressor casing are sealed by means of O-rings.

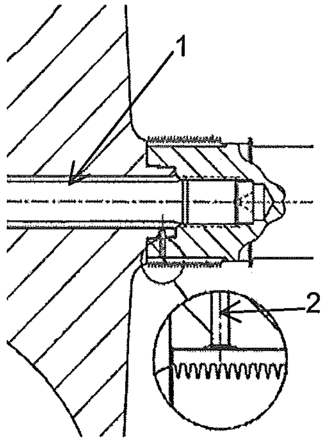
The gas flow is accelerated in the suction nozzle by a reduction of flow cross section to impeller inlet diameter.

E 2.2 Rotor

The rotor consists of compressor shaft, which is also the gear pinion shaft and the impeller/s.

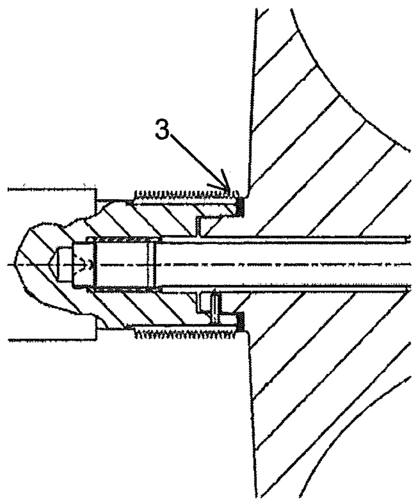
To transfer the remaining axial load from compressor stages and helical gear from the shaft to the axial bearings, the rotor is provided with bearing contact surfaces.

Impeller and pinion shaft are connected by means of microspline. The torque is transferred from shaft to impeller by means of axial ring surfaces, which engage on account of special surface treatment and very high surface pressing in the metal-crystalline range. This results in high coefficients of adhesion.



Connection of 1st and 3rd stage pinion shaft

1 Tie bolt
2 Dowel pin
3 Shim



Connection of 2nd and 4th stage pinion shaft

1 Tie bolt
2 Dowel pin
3 Shim

A press fit ascertains reproducible impeller centering in all operation conditions. Exact identical positioning of the impeller toward the shaft during dismantling and assembly works is safeguarded by positioning pins.

A hydraulically tensioned tie bolt is used as fastening element.

- **Impellers**

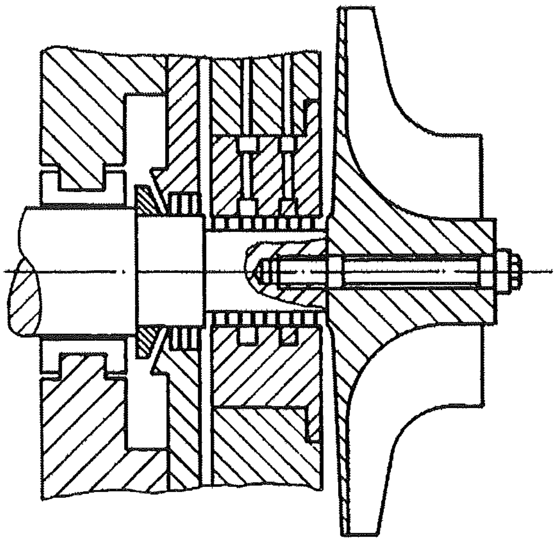
H Series compressors are equipped with open precision cast impellers made of stainless steel (17-4 PH) and backward curved blades offering highest efficiency, wide control range and optimum increase in delivery head to the surge limit.

- **Balancing of impeller**

Prior to final assembly, the impeller is dynamically balanced and checked for cracks before and after an overspeed test.

E 2.3 Shaft seal

Shaft seals are employed to seal impeller rear and gear, i.e. to minimize leakages.



Labyrinth seals consist of shaft-side sealing teeth made by shrinking labyrinth sleeves made of stainless steel on the shaft, which then cut into mounted casing-side aluminium rings with almost zero clearance.

This avoids potential damage to the pinion shaft caused by abrasion.

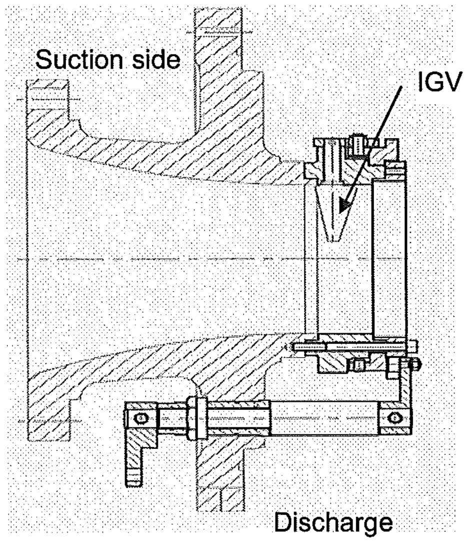
Please refer to the drawing and P&I diagram in the annex execution of the seal.

E 2.4 Inlet guide vanes (stage 1)

The inlet guide vanes (IGV) are a standardized assembly located in the suction casing. It consists of the following components:

- A vane bearing ring housing adjustable guide vanes with guide vane lever borne in maintenance-free bushes.
- The fork-type guide vane lever encloses a ball roller borne on the carrier ring.
- The carrier ring is actuated by an external lever, a shaft borne in a bush located in the suction cover, an internal lever with curved roller.
- Guide vane position is read at a scale, the range of which is delimited by limit switches.
- Inlet guide vanes are driven pneumatically, as shown in detailed drawing included in chapter H.

This mechanism obtains concurrent, even, and stepless adjustment of all inlet guide vanes.

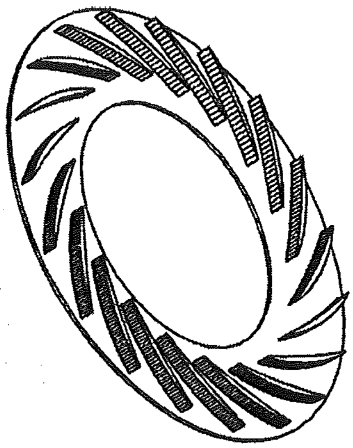


By means of the inlet guide vanes, gas flow is deflected in direction of rotation upstream of the impeller, thereby reducing the amount of volumetric flow (0° to -80°).

If positioned opposed to the direction of impeller rotation (0° to + 20°), the volumetric flow and/or pressure can be increased.

E 2.5 Diffuser guide vanes (stationary, 1 to 3)

The diffuser guide vanes are constructed as a ring with aerodynamically shaped vane profiles built-in the parallel-walled plate-type diffuser.



E 2.6 Gear

A single helical spur gear is used to transfer power and reach operating speed. The gear consists of an oil-tight casing, horizontally split, in which the driving shaft with tooth and the pinion shafts are arranged. The compressor impellers are arranged in an overhung position on the pinion shafts. Power is transferred from the wheel shaft via the wheel toothing onto the pinion shafts and from there to the impellers.

Bearings and toothing are lubricated by pressurized oil. Bearing design allows of measuring temperatures in the bearing. To seal the shafts, slinger ring and an additional mechanical seal are employed.

The compressor casing is fastened on the gear. Inspection and maintenance work on the gear is feasible without dismantling compressor parts, as the gear cover can be lifted separately.

For further details, refer to manufacturer's operating instructions in the annex.

E 2.7 Bearings

- **Driving shaft**

The driving shaft of the gear is born in compound journal bearings.

- **High-speed rotors**

High-speed rotors are born in radial tilting pad bearings. Axial bearings are designed as multi loaded bearings.

Bearings are lubricated centrally.

The design of bearing clearance is not only based on a sufficient amount of oil being pressed through the gap; it also considers the temperature impact so that rotors stand out for good running stability, e.g. they are insensitive to vibration even when passing through critical speeds.

E 2.8 Coupling

The driving power is transferred from motor to gear shaft via a coupling.

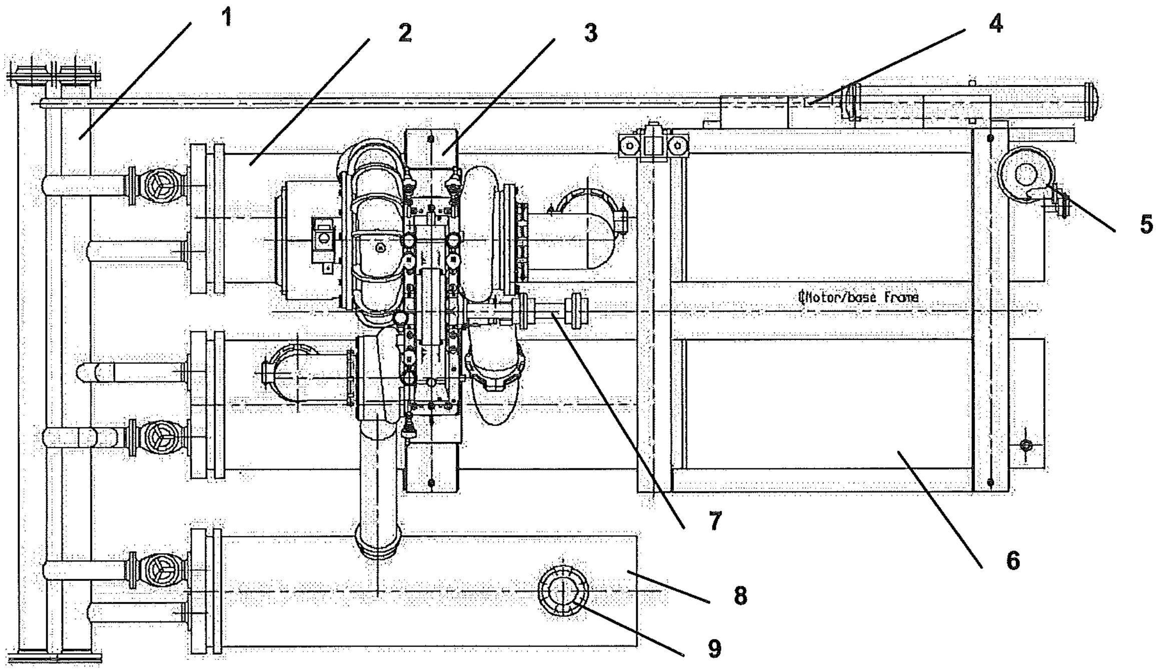
The coupling is designed as **toothed coupling**. These torsionally rigid elements of connection are employed, if high driving powers must be transferred and elasticity is not called for.

To compensate for axial displacement, two ball-type toothings are required. One coupling is made up by two coupling halves. Hubs can be taken out without displacing motor or gear, if distance sleeves are employed.

For drawing, refer to section H.

E 3 Plant parts

Made from drawing no.: 6970 301 965



1	Water header	2	Cooler stage 1
3	Gear box	4	Oil cooler
5	Oil demister	6	Oil tank
7	Coupling	8	After cooler
9	Discharge outlet		

E 3.1 Supporting structure

- **Foundation**

The foundation must be designed in a way that:

- vibrations originating from the surroundings, e.g. from other machinery, must not be transmitted to the compressor and
- no vibrations of the foundation, resonant with compressor speed must not occur.

Anchorage of compressor and plant parts is effected to indications included in the foundation plan by means of anchor or foundation bolts fastened by grouting in anchor holes or logs. For plant parts such as coolers, oil supply system and other secondary aggregates plugs are used frequently.

The contractor in charge of construction of the foundation shall bear full responsibility for the completion, adherence to dimensions, stability and vibration properties well matched to the machine.

- **Integral base frame**

The integral base frame of the centrifugal compressor contains the inter stage gas coolers with brackets and the oil tank. This base frame is also carrying the driver.

E 3.2 Lubricating system

The lubricating system supplies all bearings, gear teeth, if required gaskets and driver with fresh oil with the oil required for lubricating and cooling purposes.

The lubricating loop starts in the oil tank, from which pumps draw in oil and press it to the lubricating places, via cooler and oil filter. From there, heated lubricating oil is returned to the tank without pressure.

In normal operation, the main oil pump provides the consumer places with oil. The auxiliary oil pump is designed to start and stop the plant; after the main oil pump has assumed oil supply, it remains on stand-by for interference in the oil system. During concurrent operation of both pumps during start-up or coast-down, the pressure in the oil system rises above the set value, if the required constant operating pressure were not controlled by means of a pressure control valve installed downstream of the filter in a branch of the supply pipe leading to the consumers. In this case, the excess oil is drained without pressure to the oil tank via a pressure keeping valve installed upstream of the oil cooler. If the oil pressure falls below the minimum value, the auxiliary oil pump is energized; only if the oil pressure continue to decrease will the main driver be tripped.

For start-up at low temperatures, the heater heats the oil to the required start-up temperature. During the heating phase, the oil is circulated in the loop by means of the auxiliary oil pump to have it heated uniformly. Venting of the vessel is ascertained.

The oil system is integrated in the base frame as extension of the cooler shell tubes.

The lubricating system consists of the following main components:

- **Oil tank**

The oil tank integrated in the base frame (extension of the cooler shell tubes) is made of steel sheet. They are provided with an opening to be able to inspect all internal surfaces.

The drain valve arranged at the lowest point of the vessel bottom is designed to drain the tank. This must always be done, if cooling or condensation water entered the lubricating system. Prior to compressor start-up, it must be opened briefly to drain water, if any. If this is to be effected more frequently, a corresponding valve can be installed at this opening. The oil tank is equipped with an electrical heater

- **Oil pumps**

Oil pumps press the oil to the consumers; they operate at the pressure stated described in section main data. The auxiliary oil pump is driven by an electric motor via a coupling. This electric motor is designed in a way that it is not overloaded using specified oils with viscosity corresponding to 20°C.

The main oil pump is directly driven by the gear. For this purpose, it is flanged to the gear. It is driven by a separate set of wheels directly from the driving shaft. Normally, only the main oil pump is operating. The electrically driven auxiliary oil pump is switched in only during centrifugal compressor start-up and coast-down.

For further information about the main oil and auxiliary pumps refer to the sub-suppliers documentation in chapter H.

- **Oil cooler**

In the oil cooler the lubricating oil, which is heated by mechanical losses of the centrifugal compressor plant and oil pump power, is cooled.

Oil coolers are designed as horizontal single coolers (oil around tubes) equipped with retractable bundle.

Coolers are equipped with oil and water-side connections for draining or venting purposes.

- **Dual oil filter**

The oil is cleaned in the dual oil filter. In it, solid matter carried in the oil is retained. The dual filter consists of two filter casings with replaceable cartridges and a two-stage switch-over device for continuous operation free of surges.

- **Oil demister**

The oil demister for the oil tank is provided with several demister cartridges. The oily leakage gas coming from the oil tank is cleaned by means of a highly efficient filter system and conducted to the atmosphere. The filtered oil is returned to the oil tank. The oil demister is arranged on top of the oil tank.

Please read manufacturer's operating manual which includes instructions on installation, operation and maintenance.

- **Piping and fittings**

Oil system piping is designed in a way that maximum suction side oil velocities of W = 0.8 m/s and discharge-side oil velocities of W = 3.0 to 4.0 m/s are not exceeded. Pipes downstream of the filter are made of stainless steel.
All other pipes, even drain and vent pipes, are made with sight glasses and shut-off valves, as shown in the P+I diagram.

Piping is designed in a way that main and auxiliary oil pump draw in oil directly from the oil tank. Non-return valves are arranged to avoid back-flow of supplied oil; in connection with purposeful conducted pipes they ascertain filling of the suction pipe of that pump which is not running.

E 3.3 Process gas pipes with accessory

- **Gas coolers**

The **gas coolers** are employed to cool the gas. They are designed as intercoolers or aftercoolers of lamellar tube bundle type, in which the gas to be cooled flows on the finside of the tube and is cooled in a certain temperature. The cooling medium flowing through the tubes in several passes receives the heat withdrawn from the gas.

Bundles are extractable. To enable optimum filling of the tube bundle, lateral walls are arranged between the tubesheets.

Drain and fill nozzles for the water chambers are located at the highest and lowest places each.

If the gas is humid, the amount of water exceeding the saturation state is separated as condensate by cooling of the gas and withdrawn.

- **Condensate trap**

The gas coolers are drained of occurring condensate by means of a condensate trap which operates automatically and passes the condensate without pressure into a collecting pipe.

For further information about the condensate trap refer to the sub-suppliers documentation in chapter H.

- **Pipes**

Pipes located between compressor and coolers, separators, if any, or valves and other stages are conducted in a way that space is saved and the gas flow is influenced favourably to reduce losses.

Connection to compressor casings, coolers etc. is effected by flanges

Connection to compressor casings, coolers etc. is effected by Victaulic couplings.

- **Conical filter (Start up strainer)**

To protect the centrifugal compressor against dirt, a conical filter is installed in the suction-side pipe, which is clamped between two welding neck flanges.

The conical filter is used only to start up the centrifugal compressor during first commissioning or subsequent to maintenance activities at the suction-side process pipes. It is a means to protect the centrifugal compressor against larger dirt particles entering it from the suction pipe. The conical filter must be removed prior to any further commissioning and or for general operation.

- **Bypass valve**

For capacity control a bypass valve (on/off or modulating) is installed.

- **Non-return flap**

It is imperative to install a non-return flap in the centrifugal compressor discharge pipe to avoid consumer-side backflow of gas to the centrifugal compressor. This flap is spring-loaded and equipped with an O-ring as sealing element. The flap is clamped between two pipe flanges.

E 3.4 Safety valves in water pipes

Safety valves are designed to protect plant parts against damage caused by over-pressure. Valves employed in this centrifugal compressor are spring-loaded. For their structure and description, refer to section H .