GRASSO

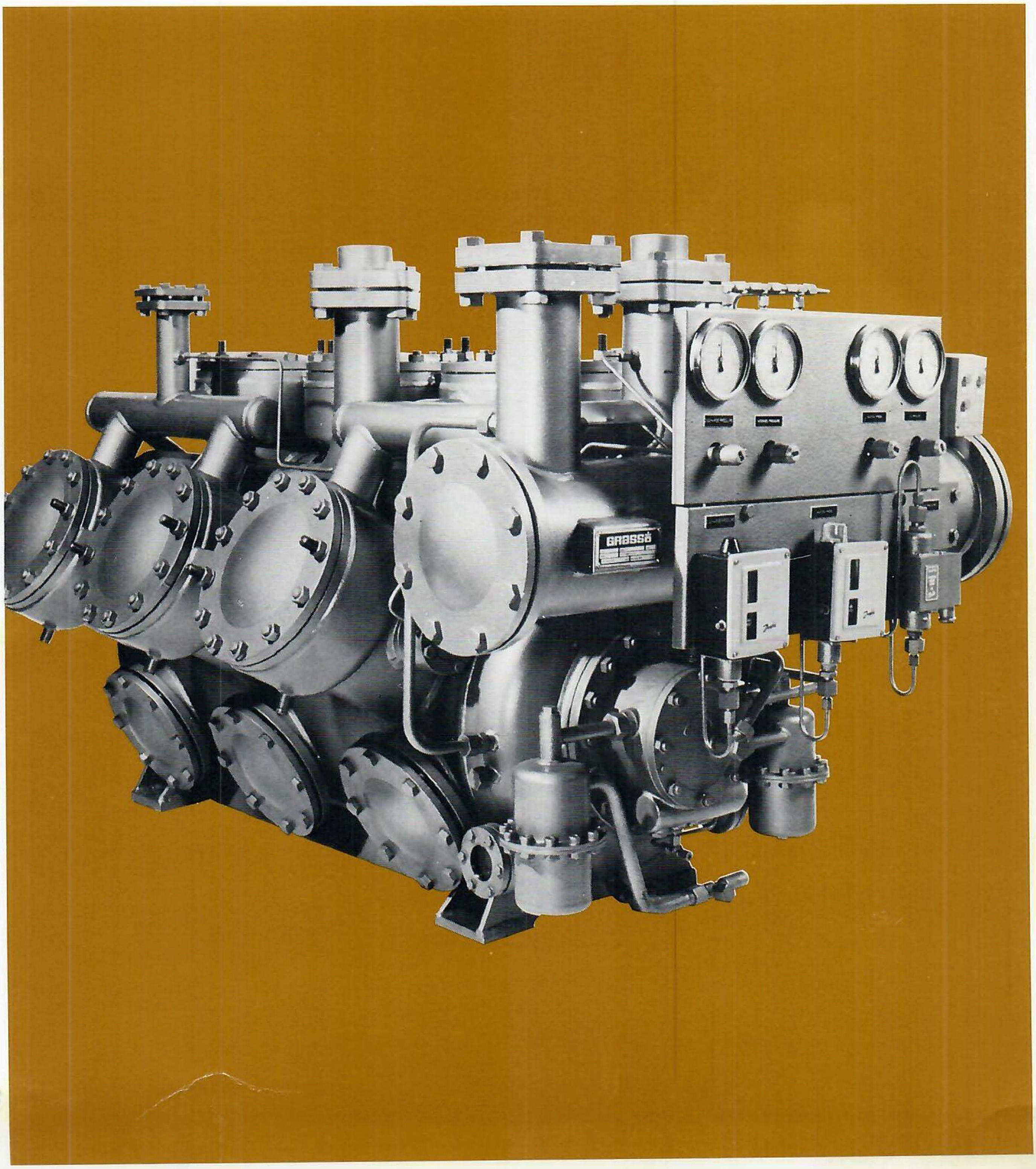
Refrigeration compressor

RC 11

Engineering Data

Single-stage, booster, two-stage

NH_3, R12, R22, R502



OUTLINE

RC11 is the designation of a series of open, single-acting, return-flow, reciprocating refrigeration compressors with trunk-type pistons and with 2 up to 12 cylinders in V- and W-arrangement.
The series consist of 15 types, of which 6 single-stage and 9 integral two-stage (compound) compressors.
The single-stage types can also be used as booster compressors.
All types have the same main characteristics, viz. a cylinder bore of 160 mm and a piston stroke of 110 mm.

TYPE DESIGNATION

The following examples will explain the type designation:

6-cylinder single-stage compressor — type RC 6 11
- Refrigeration compressor (RC)
- Number of cylinders (6)
- Piston stroke in cm (11)

9-cylinder two-stage compressor — type RC 7 2 11
- Refrigeration Compressor (RC)
- Number of LP cylinders (7)
- Number of HP cylinders (2)
- Piston stroke in cm (11)

APPLICATION

The compressors are designed for general industrial (heavy duty) operation at evaporating temperatures between -65 and +10 °C (cooling, freezing, air conditioning, heat pump systems) with the current refrigerants NH_3, R12, R22 and R502.
For the exact limits of operation and fields of application, refer to Data Sheets No. 7, 8A, 8B and 8C.
The compressors are also suitable for other refrigerants such as R13 (cascade systems), R13B1 (two-stage systems only) or R114 (heat pump systems) and for compressing gases such as propane, butane, sulphur dioxide, ethylene, etc. in chemical processes or for pumping purposes.
For all these particular applications the compressor manufacturer should be consulted.

DRIVE SYSTEM

In principle the compressors are designed to be driven by an electric motor, either direct or by means of V-belts, the maximum speed (≈ normal service speed) being 1000/min.
Using V-belt drive, a total of 10 standard service speeds are available down to a minimum of approx. 400/min.
The normal direction of rotation, determined by the operation of the standard oil pump, is counter-clockwise when facing the shaft end.
A special reversed-acting oil pump can be fitted at a surplus price, allowing a clockwise direction of rotation. This enables a tandem-arrangement of two-compressors, each of them installed on either side of one single electric drive motor with two drive ends or the compressor to be direct driven by an internal combustion engine (diesel or natural gas) which normally has a fixed direction of rotation.

SELECTION

Selection takes place on the basis of the standard bare compressor.
For methods of selection refer to Data Sheet No. 9.

The standard bare compressor can be extended with accessoiries to meet customers requirements. For a review of these accessories refer to Data Sheets No. 12A and 12B.

QUALITY CONTROL

During manufacturing the complete assembled compressor is given a pressure test with dry air to check it for mechanical strength and gastightness. The pressure for testing the mechanical strength is at least 1.5 times the max. design pressure.
Before leaving the works each reciprocating compressor undergoes a test run with air during approx. 15 hours as a general mechanical check only.
Moreover, approx. 3% of the total number of compressors manufactured is taken at random for a so-called "statistical check". This is a quality inspection carried out by the Laboratory of the Development Department according to the international Standard ISO 917*, whereby the compressor operates with refrigerant and under conditions prevailing in practice in order to determine capacity and power consumption at full load as well as at part load.
This inspection also includes a vacuum test and an examination of all important compressor functions.

* From this Standard only method D (refrigerant vapour flow meter in suction line) as so-called "Principal test" is used in actual practice.

ACCEPTANCE TEST

It is also possible, on special request and at an extra charge, to perform an "Acceptance Test" under design conditions, witnessed by the customer.

SURVEY CERTIFICATE

All compressor types can be delivered at an extra charge with a survey certificate of the following Classification Bureaus:

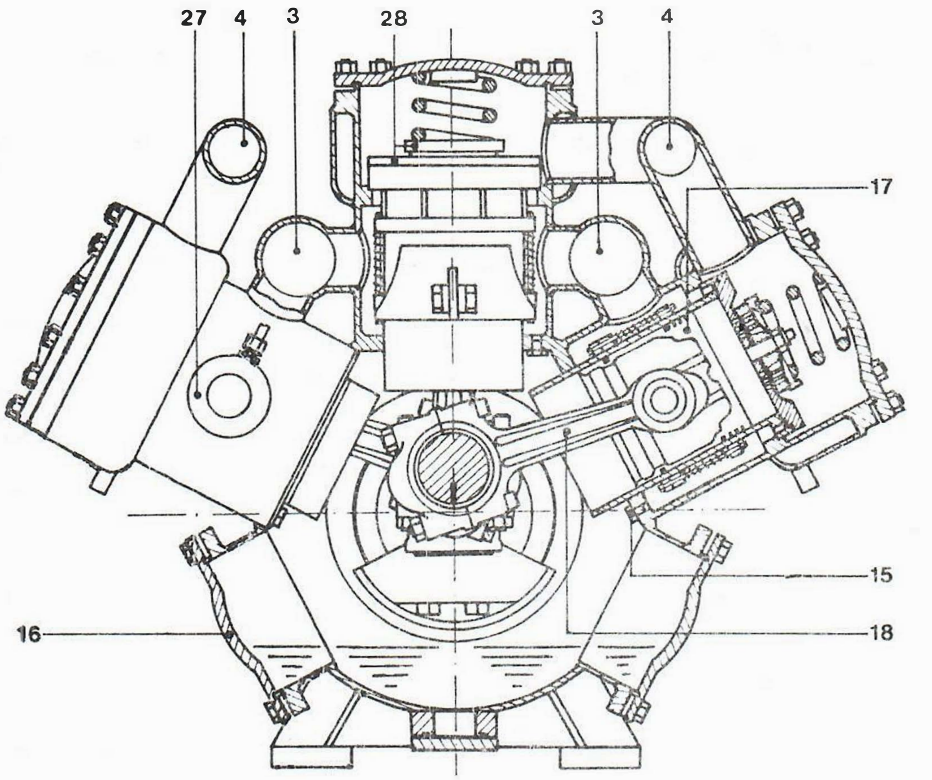
- Lloyds Register of Shipping
- Germanischer Lloyd
- Bureau Veritas
- Det Norske Veritas
- Register of Shipping USSR
- Deutsche Schiffs-Revision und -Klassifikation (D.S.R.K.)
- Rinave Portuguesa
- American Bureau of Shipping

The type designation of compressors with survey certificate is KRC11.

DELIVERY

As a standard the compressors are delivered without oil. All installation connections are blanked off and the compressor is filled with nitrogen at atmospheric pressure.
The external finish consists of blue hammertone paint or, if required to special order, green primer only.
Each compressor is accompanied by an instruction manual containing particulars on operation, inspection and maintenance as well as illustrated parts lists.

DESIGN DETAILS OF STANDARD BARE COMPRESSOR



1. Crankcase
2. Cylinder jacket
3. Suction manifold
4. Discharge manifold
5. Cylinder liner with valve-lifting mechanism
6. Cylinder head cover
7. Cooling water jacket
8. Bearing cover
9. Oil pump
10. Rotary shaft seal
11. Intermediate bearing
12. Oil sight glass
13. Flanged connection for marine oil reservoir (optional)
14. Sleeve for heating element
15. Non-return valve
16. Service cover
17. Piston
18. Connecting rod
19. Crankshaft
20. Thrust bearing
21. Counterweight
22. Suction connection
23. Discharge connection
24. Gas suction strainer
25. Oil discharge filter
26. Oil charge and drain valve
27. Valve lifting control piston
28. Suction and discharge valve assembly
29. Buffer spring

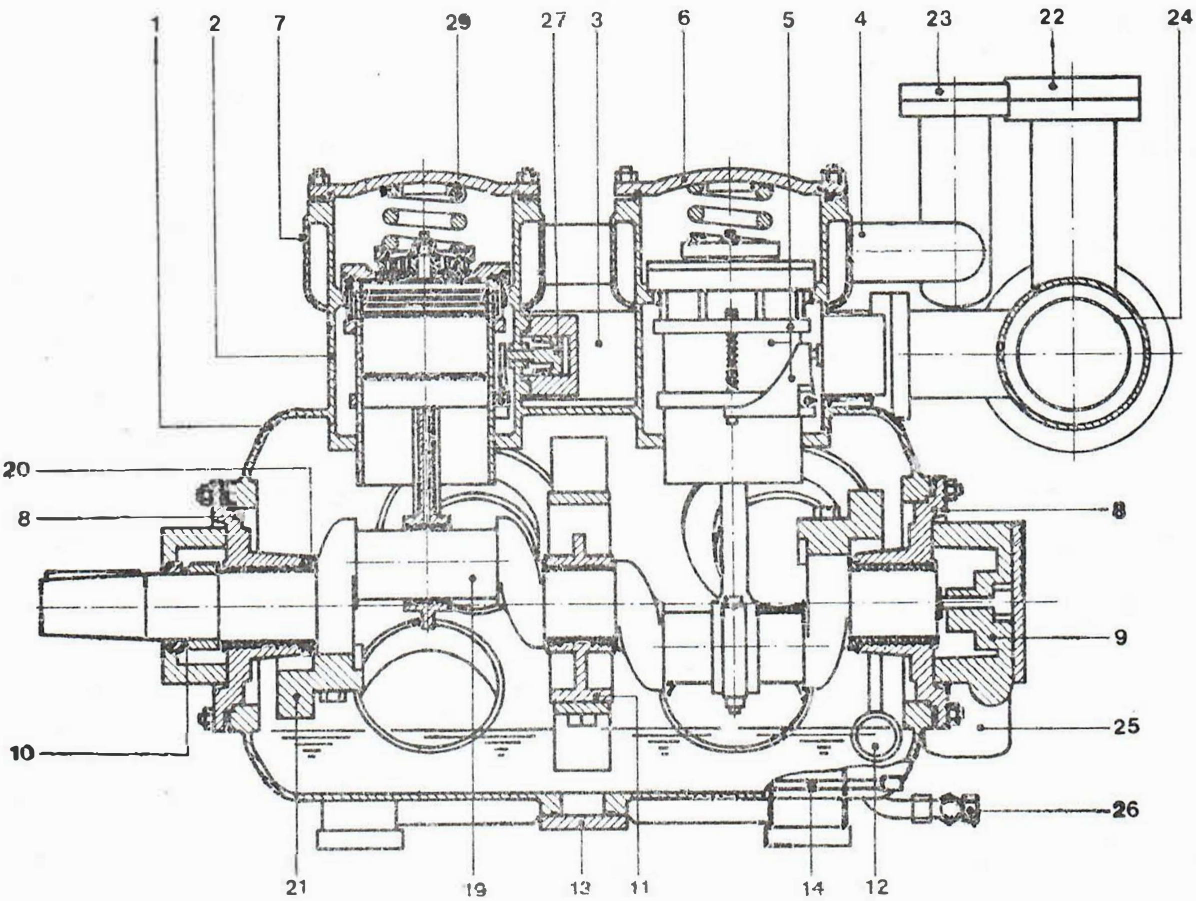


Fig. 1 Design of standard bare compressor (RC 611)

1. COMPRESSOR HOUSING *(see fig. 1)*

The compressor housing is of welded steel construction and comprises the crankcase (1), the cylinder jackets (2) and the suction and discharge manifolds (3 and 4). In the lower part of each cylinder jacket, an interchangeable cylinder liner (5) is provided. The annular space between cylinder liner and jacket serves as suction chamber. The discharge chamber is formed by the upper part of the cylinder jacket shut off by the cylinder head cover (6).
In situ of the discharge chamber, each cylinder jacket is provided with a water cooling jacket (7).

The crankshaft runs in bearing covers (8) shutting off both sides of the crankcase and on which also the oil pump (9) and the rotary shaft seal housing (10) are fitted.
In the case of compressors whose crankshaft is provided with intermediate bearings (11), one or more angular supports for the bearing blocks are welded in the crankcase.

The oil required for compressor lubrication is at the bottom of the crankcase. To determine the oil level, a sight glass (12) is located on both sides in an even line.
Especially for use on board ships, the bottom of the crankcase of compressors having four or more cylinders can be provided with a flanged connection (13) for a marine oil reservoir, which can be supplied as an additional accessory.
To heat the oil, if necessary, all compressors have a sleeve (14) welded onto the outside of the crankcase bottom, into which a heating element (available as an accessory) can be inserted.

The oil which is separated in the suction chamber from the refrigerant vapour can flow back to the crankcase via a non-retun valve (15). This valve is fitted between suction chamber and crankcase in the lower supporting ring of the cylinder liner. There is no valve fitted in the HP-cylinders of two-stage compressors.
The valve, normally open, closes when the crankcase pressure exceeds the pressure in the suction chamber.

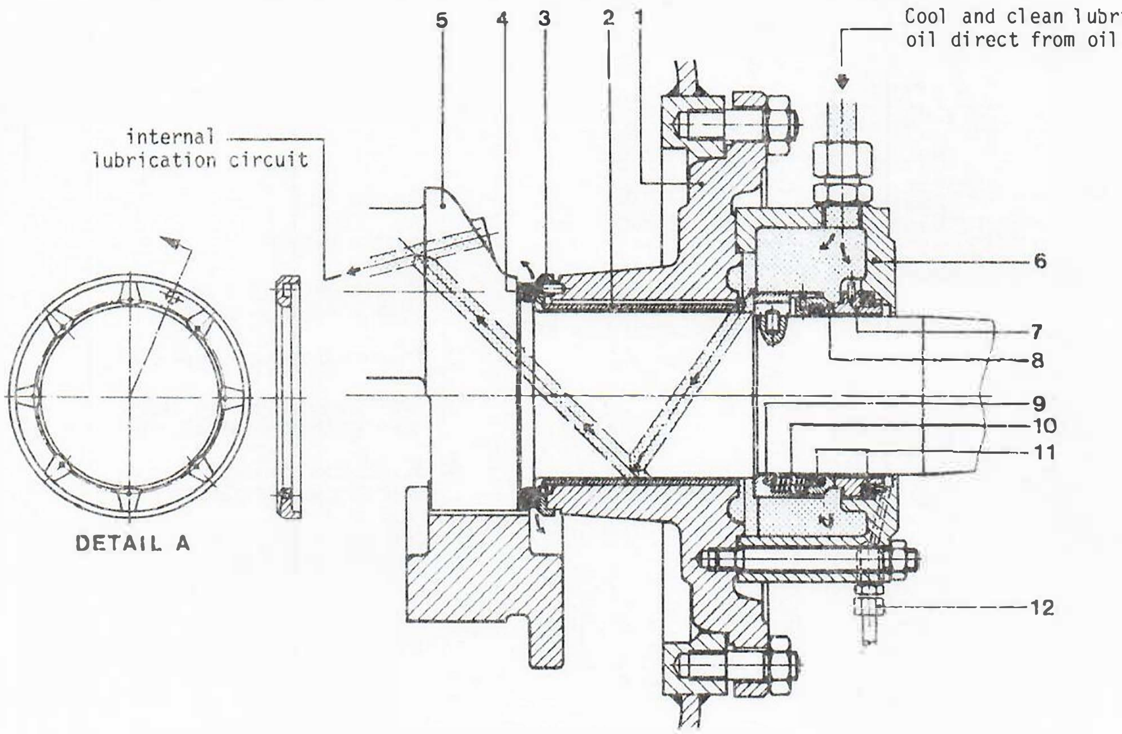
The crankcase interior is accessible via one or more service covers (16) provided on both sides of the crankcase.

2. CYLINDERS AND MOVING PARTS *(see fig. 1)*

The cylinders are formed by interchangeable, centrifugally cast iron cylinder liners pressed into supporting rings in the cylinder jackets. The collar on top of the cylinder liners is provided with a circle of openings and acts as seat for the suction valve ring.
In the cylinder liners light metal pistons (17) are located, on which 3 compression rings and 2 oil scraper rings are fitted.

The aluminium connecting rods (18) have a split-type big end, in which white metal lined steed precision bearing shells are positioned. To provide bearing for the gudgeon pin, a bronze bush, or, in the case of HP cylinders of two-stage compressors, two needle bearings are pressed into the small end bore.

The nodular cast iron crankshaft (19) is mounted in slide bearings consisting of interchangeable, one-piece white metal lined steel bushes pressed into the bearing covers. Intermediate bearings are built up of split-type, white metal lined steel bearing shells located in bearing blocks likewise of the split-type. The axial crankshaft thrust is taken up by a special heavy duty thrust bearing (20) on the driving end, consisting of a rotation hardened steel ring, pressed onto the crankshaft, and a stationary bronze ring with 8 separately fed oil chambers, provided against the bearing cover around the bearing bush (see also fig. 2).
The crankshaft is fitted with bolted counterweights (21) and the whole is dynamically balanced. The tapered shaft end with key for taking up flywheel or coupling is carried gastight through the bearing cover.



1. Bearing cover
2. Bearing bush
3. Bronze thrust ring (see detail A)
4. Steel thrust ring
5. Crankshaft
6. Shaft seal housing
7. Stationary counter-slip ring
8. Rotary slip ring
9. Spring holder
10. Spring
11. O-ring
12. Oil leakage drain of rotary shaft seal

Fig. 2 Thrust bearing and rotary shaft seal

3. ROTARY SHAFT SEAL *(see fig. 2)*

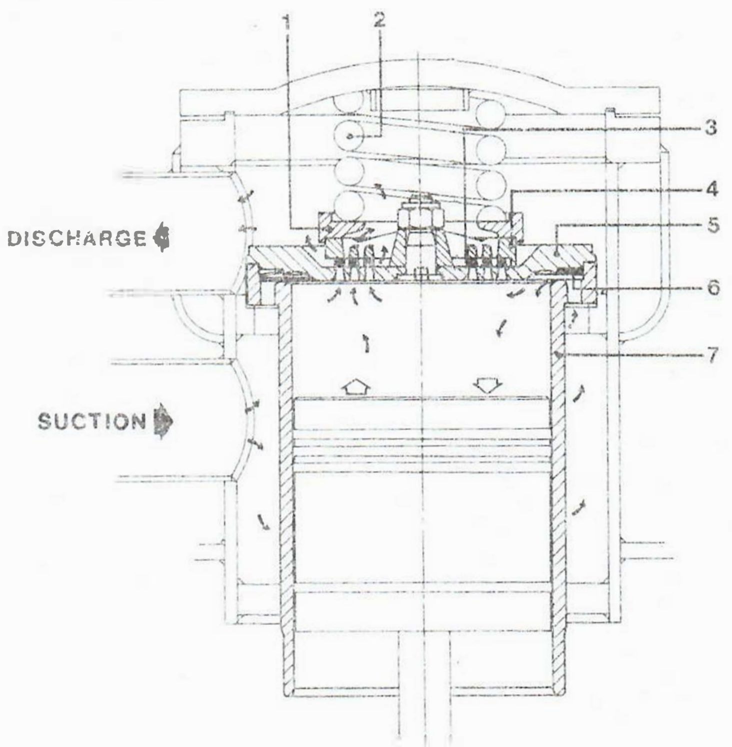
In order to pass the crankshaft gastight outwards, the compressor is provided with a special rotary shaft seal, the parts of which are retained in a housing mounted against the bearing cover on the driving end.
The sealing between rotating and stationary parts is effected on the sliding surface between a chrome alloy cast iron slip ring rotating with the crankshaft and a stationary carbon impregnated PTFE counter-slip ring fitted in the housing. For this purpose the sliding surface of both slip rings is ground to extreme finish and lapped.
The counter-slip ring is secured against rotation by a lock screw fitting into a recess of the housing. The slip ring can slide over the crankshaft and is pressed on to the counter-slip ring by means of springs. It is carried by a spring holder which, in turn, is locked on the crankshaft by a driving pin. O-rings are provided to ensure the sealing between slip ring and housing.
To remove sufficiently the frictional heat developed by the slip rings, the shaft seal is incorporated in the relative cool main stream of the lubricating oil circuit (See further chapter 9, Lubrication System)

4. SUCTION AND DISCHARGE VALVES *(see fig. 3)*

The suction and discharge valves of the compressor are of the ring type. They contain steel alloy valve rings pressed in rest position, under spring tension, onto a seat and shutting off the openings provided in it. The lift of the valve rings is limited by a stroke limitor.

The suction valve only has one valve ring retained, together with two sinusoidal springs, between the valve seat type collar of the cylinder liner and a stroke limitor. The stroke limitor of the suction valve is centred by the collar of the cylinder liner.

The discharge valve consists of a valve seat and a stroke limitor fixed together by means of a central bolt and between which three valve rings, each with two sinusoidal springs, are placed concentrically. The discharge valve seat and the suction valve stroke limitor are one and the same. The whole assembly is pressed onto the collar of the cylinder liner by a powerful buffer spring. This buffer spring prevents serious damage to the compressor due to an incidental slight liquid hammer.



1. Spring cup
2. Buffer spring
3. Discharge valve ring with sinusoidal springs
4. Discharge valve stroke limitor
5. Suction valve stroke limitor, also discharge valve seat
6. Suction valve ring with sinusoidal springs
7. Cylinder liner, also suction valve seat

Fig. 3 Suction and discharge valve assembly

5. VALVE-LIFTING MECHANISM *(see fig. 4)*

In order to enable the compressor to start fully unloaded, all cylinders have been put out of action mechanically by suction valve ring lifting during compressor standstill. For this purpose a pressure ring is provided in each cylinder, which can move up and down around the cylinder liner. The pressure ring is provided at the top with push pins capable of lifting the suction valve ring from its seat via openings in the collar of the cylinder liner. On the lower part of the liner a supporting ring is fitted to which a semi-circular lever is hinged. This lever is controlled by the stem of a piston provided in a housing on the outside of the cylinder jacket. The piston can be moved inwards by control oil pressure from the oil pump.
On the other side the lever is connected to the pressure ring by two tie bolts passing through the supporting ring. Both tie bolts are surrounded by a spring provided between supporting ring and pressure ring.
At compressor standstill there is no oil pressure and the pressure ring is forced upwards by the springs, causing the push pins to keep the suction valve ring lifted. The control piston is forced outwards by a separate spring (this does not apply to the control pistons of the HP cylinders of two-stage compressors).

As soon as the compressor has been started, control oil pressure is admitted to the piston after some time, determined by the hydraulic time delay in the oil pump housing (see chapter 8). The piston moves inwards, so that the lever tilts and pulls the pressure ring with push pins downwards against spring tension via the tie bolts.
The suction valve ring then descends on to its seat and the cylinder is in operation.

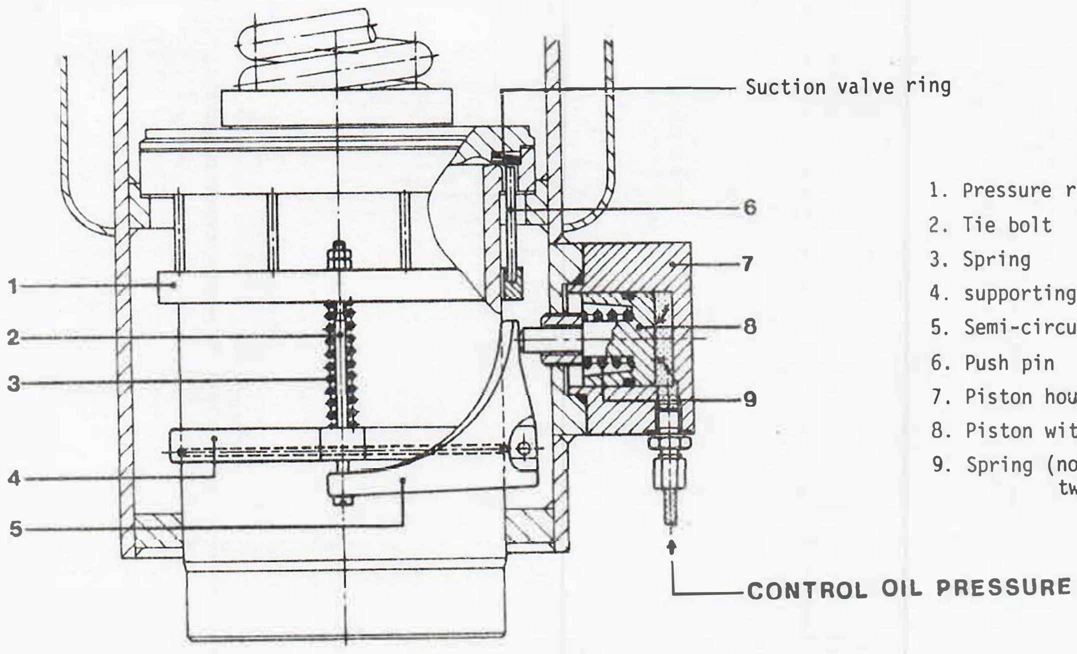
The valve-lifting mechanisms are also used for capacity control by successively cutting in or out cylinders or cylinder groups, which is controlled either manually or electrically (see Data Sheets No. 15, 16, 17A and 17B).

6. PRINCIPAL CONNECTIONS, GAS SUCTION STRAINER AND PRESSURE EQUALIZING

The suction and discharge chambers of the separate cylinders open, via one or more manifolds, into a single suction and discharge connection with flange, with which the compressor is coupled to the refrigerating plant via stop valves. The (LP) suction connection is fitted on the horizontal suction strainer housing on the oil pump side of the compressor, in which a removable metal strainer is provided for purifying the intake refrigerant gas. In the case of two-stage compressors, an extra LP discharge and HP suction connection is provided, which can be interconnected via an interstage cooler. The HP suction connection is not provided with a gas strainer.
Between suction strainer housing and crankcase an equalizing line is provided in order to prevent the crankcase pressure from rising due to piston leakage. Consequently, the crankcase pressure is equal to suction pressure for single-stage as well as for two-stage compressors.
All principal connections have nipples for connecting pressure gauges or pressure safety switches.

7. OVERFLOW SAFETY VALVES

In order to prevent excessive pressure difference in the compressor, one or more overflow safety valves (dependent on the type of compressor) are provided.
These overflow safety valves act on the difference between suction and discharge pressure and moreover, in the case of two-stage compressors, on that between suction and intermediate pressure.
The valves are fitted externally between the suction manifold and the HP and/or LP discharge manifold. The overflow safety valve is a spring-loaded valve adjusted at the works. When there is an excessive pressure difference, the gas is blown off to the suction side.



1. Pressure ring
2. Tie bolt
3. Spring
4. supporting ring
5. Semi-circular lever
6. Push pin
7. Piston housing
8. Piston with stem
9. Spring (not in HP cylinders of two-stage compressors)

Fig. 4 Valve-lifting mechanism

NH_3 ZWEISTUFIGE VERDICHTUNG
System A: Einspritz-Gaszwischenkühlung

Erläuterung zu den Leistungstabellen auf Seiten 41 bis 48

Kältemittelkreislauf (Siehe Seite 39)

Symbole

a = zweistufiger Verdichter
b = Einspritz Gaszwischenkühler
c = thermostatisches Expansionsventil
d = Ölabscheider
e = Verflüssiger
f = Drosselregulierventil zur Speisung des Verdampfers
g = Verdampfer

Q_o = Kälteleistung
P_e = Kraftbedarf (effektive Leistungsaufnahme)
n = Höchstdrehzahl (U/min)
t_c = Verflüssigungstemperatur
t_m = Sättigungszwischentemperatur
t_o = Verdampfungstemperatur
Δt_m = HD-Saugüberhitzung
Δt_o = ND-Saugüberhitzung
p_c = absoluter Verflüssigungsdruck
p_m = absoluter Zwischendruck
p_o = absoluter Verdampfungsdruck
h = Enthalpie

Bedingungen

Kälteleistung und Kraftbedarf beziehen sich auf eine Anlage ohne Flüssigkeitsunterkühlung im Verflüssiger und ohne Überhitzung im Verdampfer (überflutete Verdampfung), jedoch mit einer festen (nützlichen) HD-Saugüberhitzung von 6 K und mit einer Anzahl verschiedener Werte von (nicht nützlicher) ND-Saugüberhitzung, die in der Saugleitung vom Verdampfer zum Verdichter auftritt.

Der Kraftbedarf und die Sättigungszwischentemperatur sind nur in geringem Masse von der variablen ND-Saugüberhitzung abhängig, weshalb sie bei jeder Kombination von Verflüssigungstemperatur und Verdampfungstemperatur nur einmal als Mittelwerte erwähnt worden sind.

Alle angegebenen Leistungen gelten für Bedingungen, unter denen die Sättigungszwischentemperatur nicht höher ist als +10 °C und, sowohl für die Niederdruck- als auch für die Hochdruckstufe, die isentropische Verdichtungstemperatur 120 °C nicht überschreitet und das Druckverhältnis nicht niedriger ist als 1,5.

Die Leistungsangaben in Dünndruck weisen darauf hin, daß unter diesen Umständen einstufige Verdichtung ebenfalls möglich ist.

Kälteleistung und Kraftbedarf sind der Drehzahl des Verdichters proportional; die mindestzulässige Drehzahl ist 400 U/min.

NH_3 COMPRESSION A DEUX ÉTAGES
Système A: refroidissement intermédiaire de gaz par injection

Guide pour l'emploi des tableaux de performances aux pages 41 jusqu'à 48

Cycle du fluide frigorigène (Voir page 39)

Symboles

a = compresseur bi-étagé
b = refroidisseur intermédiaire de gaz par injection
c = détendeur thermostatique
d = séparateur d'huile
e = condenseur
f = dispositif régulateur d'étranglement pour l'alimentation de l'évaporateur
g = évaporateur

Q_o = puissance frigorifique
P_e = consommation d'énergie (puissance effective à l'arbre)
n = vitesse de rotation maximum (tr/min.)
t_c = température de condensation
t_m = température intermédiaire de saturation
t_o = température d'évaporation
Δt_m = surchauffe d'aspiration H.P.
Δt_o = surchauffe d'aspiration B.P.
p_c = pression de condensation absolue
p_m = pression intermédiaire absolue
p_o = pression d'évaporation absolue
h = enthalpie

Conditions

La puissance frigorifique et la consommation d'énergie se rapportent à une installation sans sous-refroidissement du liquide dans le condenseur est sans surchauffe dans l'évaporateur (évaporation noyée), mais avec une surchauffe d'aspiration H.P. fixe (utile) de 6 K et avec un nombre de valeurs différentes de la surchauffe d'aspiration B.P. (non utile), qui se produit dans le conduit d'aspiration de l'évaporateur au compresseur.

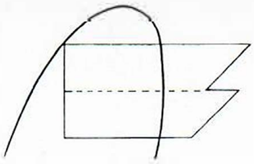
La consommation d'énergie et la température intermédiaire de saturation ne dépendent que pour une faible partie du degré de surchauffe d'aspiration B.P. variable, raison pour laquelle elles n'ont été indiquées qu'une seule fois comme les valeurs moyennes pour chaque combinaison de la température de condensation et de la température d'évaporation.

Toutes les performances indiquées s'entendent pour des conditions dans lesquelles la température intermédiaire de saturation n'est pas supérieure à +10 °C et, tant pour l'étage B.P. que pour l'étage H.P., la température de refoulement isentropique ne dépasse pas 120 °C et le rapport de pression n'est pas inférieur à 1,5.

Les performances imprimées en caractères maigres indiquent que dans ces conditions il est également possible d'effectuer la compression à un étage.

La puissance frigorifique et la consommation d'énergie sont proportionnelles à la vitesse de rotation du compresseur, dont la valeur minimale admissible est de 400 tr/min.

NH_3



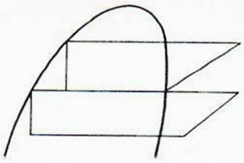
GRASSO
RC 8411

Two-stage, system A

n = 1000 rpm

↓ t_o(°C)	↓ Δt_o(K)	→ t_c(°C)	+20	+25	+30	+35	+40	+45
—15	0	Q_o (kcal/h)	505 700	494 600	483 300	471 900	460 400	448 700
	5		494 400	483 600	472 600	461 400	450 100	438 700
	10		483 900	473 200	462 500	451 500	440 500	429 300
	—	t_m(°C)	+5.6	+6.0	+6.4	+6.8	+7.3	+7.9
		P_e (kW)	132.2	143.0	154.5	166.7	179.6	193.0
—20	0	Q_o (kcal/h)	409 200	400 100	390 800	381 400	371 900	362 300
	5		400 200	391 300	382 200	373 000	363 700	354 300
	10		391 800	383 000	374 100	365 100	356 000	346 800
	—	t_m(°C)	+0.2	+0.6	+1.1	+1.6	+2.1	+2.7
		P_e (kW)	120.4	130.4	141.0	152.1	163.7	175.5
—25	0	Q_o (kcal/h)	320 600	313 300	305 800	298 300	290 600	282 900
	5		313 800	306 600	299 300	292 000	284 500	276 900
	10		307 100	300 100	293 000	285 700	278 400	271 000
	—	t_m(°C)	—5.8	—5.3	—4.7	—4.1	—3.5	—2.8
		P_e (kW)	108.5	117.5	126.9	136.7	146.7	156.7
—30	0	Q_o (kcal/h)	248 300	242 500	236 600	230 600	224 500	—
	5		242 900	237 200	231 400	225 600	219 600	—
	10		237 700	232 100	226 500	220 700	214 900	—
	—	t_m(°C)	—11.5	—10.9	—10.3	—9.6	—8.9	—
		P_e (kW)	97.4	105.3	113.4	121.6	129.8	—
—35	0	Q_o (kcal/h)	190 000	185 400	180 700	176 000	—	—
	5		185 900	181 400	176 800	172 200	—	—
	10		181 900	177 500	173 000	168 500	—	—
	—	t_m(°C)	—17.0	—16.4	—15.7	—14.9	—	—
		P_e (kW)	86.9	93.5	100.1	106.7	—	—
—40	0	Q_o (kcal/h)	143 500	139 900	—	—	—	—
	5		140 300	136 800	—	—	—	—
	10		137 300	133 800	—	—	—	—
	—	t_m(°C)	—22.3	—21.5	—	—	—	—
		P_e (kW)	76.6	81.9	—	—	—	—
—45	0	Q_o (kcal/h)	106 500	—	—	—	—	—
	5		103 900	—	—	—	—	—
	10		101 700	—	—	—	—	—
	—	t_m(°C)	—27.4	—	—	—	—	—
		P_e (kW)	66.3	—	—	—	—	—
—50	0	Q_o (kcal/h)	—	—	—	—	—	—
	5		—	—	—	—	—	—
	10		—	—	—	—	—	—
	—	t_m(°C)	—	—	—	—	—	—
		P_e (kW)	—	—	—	—	—	—
—55	0	Q_o (kcal/h)	—	—	—	—	—	—
	5		—	—	—	—	—	—
	10		—	—	—	—	—	—
	—	t_m(°C)	—	—	—	—	—	—
		P_e (kW)	—	—	—	—	—	—

NH_3



GRASSO

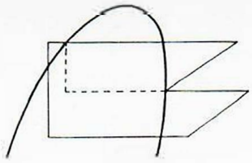
RC 8411

Two-stage, system C

n = 1000 rpm

↓ t_o(°C)	↓ Δt_o(K)	→ t_c(°C)	+20	+25	+30	+35	+40	+45
—15	0	Q_o (kcal/h)	531 300	528 200	524 900	521 500	—	—
	5		520 100	517 100	513 900	510 500	506 900	—
	10		509 500	506 600	503 400	500 100	496 600	—
	—	t_m(°C)	+6.5	+7.3	+8.1	+9.0	+9.9	—
		P_e (kW)	134.1	145.9	158.7	172.3	186.8	—
—20	0	Q_o (kcal/h)	437 900	435 200	432 300	429 300	426 100	422 600
	5		428 700	426 000	423 300	420 300	417 200	413 800
	10		420 100	417 500	414 800	411 900	408 800	405 500
	—	t_m(°C)	+1.4	+2.3	+3.1	+4.0	+4.9	+5.9
		P_e (kW)	122.8	133.8	145.6	158.2	171.4	185.3
—25	0	Q_o (kcal/h)	349 700	347 400	345 000	342 400	339 600	336 700
	5		342 600	340 400	338 000	335 500	332 800	329 900
	10		335 700	333 500	331 200	328 700	326 000	323 200
	—	t_m(°C)	—4.1	—3.3	—2.4	—1.4	—0.5	+0.6
		P_e (kW)	111.5	121.5	132.2	143.4	155.1	167.3
—30	0	Q_o (kcal/h)	276 500	274 400	272 200	269 900	267 400	264 900
	5		270 800	268 700	266 600	264 300	261 900	259 300
	10		265 300	263 300	261 200	258 900	256 600	254 100
	—	t_m(°C)	—9.5	—8.7	—7.7	—6.8	—5.7	—4.7
		P_e (kW)	100.9	109.9	119.2	129.0	139.0	149.2
—35	0	Q_o (kcal/h)	215 200	213 700	212 000	210 100	208 100	—
	5		210 800	209 200	207 600	205 700	203 800	—
	10		206 400	204 900	203 300	201 500	199 600	—
	—	t_m(°C)	—14.9	—14.0	—12.9	—11.9	—10.8	—
		P_e (kW)	90.7	98.5	106.5	114.7	122.9	—
—40	0	Q_o (kcal/h)	165 400	163 900	162 300	160 600	—	—
	5		161 900	160 400	158 900	157 200	—	—
	10		158 600	157 100	155 600	153 900	—	—
	—	t_m(°C)	—20.1	—19.1	—18.0	—16.9	—	—
		P_e (kW)	80.8	87.2	93.6	100.1	—	—
—45	0	Q_o (kcal/h)	124 900	123 600	122 200	—	—	—
	5		122 000	120 800	119 400	—	—	—
	10		119 600	118 300	117 000	—	—	—
	—	t_m(°C)	—25.1	—24.0	—22.8	—	—	—
		P_e (kW)	70.7	75.7	80.6	—	—	—
—50	0	Q_o (kcal/h)	92 900	91 800	—	—	—	—
	5		90 900	89 800	—	—	—	—
	10		89 000	87 900	—	—	—	—
	—	t_m(°C)	—29.8	—28.5	—	—	—	—
		P_e (kW)	60.9	64.5	—	—	—	—
—55	0	Q_o (kcal/h)	—	—	—	—	—	—
	5		—	—	—	—	—	—
	10		—	—	—	—	—	—
	—	t_m(°C)	—	—	—	—	—	—
		P_e (kW)	—	—	—	—	—	—

NH_3



GRASSO

RC 8411

Two-stage, system D

n = 1000 rpm

↓ t_o(°C)	↓ Δt_o(K)	→ t_c(°C)	+20	+25	+30	+35	+40	+45
	0		514 100	511 100	507 900	504 400	500 800	—
	5	Q_o	503 300	500 300	497 100	493 800	490 200	—
—15	10	(kcal/h)	493 000	490 100	487 000	483 700	480 300	476 600
		t_m(°C)	+5.7	+6.5	+7.3	+8.2	+9.1	+9.8
	—	P_e (kW)	132.2	144.0	156.6	170.1	184.5	198.9
	0		423 900	421 300	418 500	415 500	412 300	409 000
	5	Q_o	415 100	412 400	409 700	406 800	403 700	400 400
—20	10	(kcal/h)	406 700	404 100	401 400	398 600	395 500	392 300
		t_m(°C)	+0.6	+1.5	+2.3	+3.2	+4.1	+5.1
	—	P_e (kW)	121.2	132.2	143.8	156.2	169.3	183.0
	0		338 800	336 500	334 100	331 500	328 800	325 900
	5	Q_o	331 900	329 700	327 300	324 800	322 200	319 400
—25	10	(kcal/h)	325 200	323 000	320 700	318 200	315 600	312 900
		t_m(°C)	—4.8	—4.0	—3.1	—2.2	—1.2	—0.2
	—	P_e (kW)	110.1	120.1	130.6	141.7	153.2	165.1
	0		267 600	265 600	263 500	261 300	259 000	256 500
	5	Q_o	262 000	260 100	258 000	255 900	253 600	251 100
—30	10	(kcal/h)	256 600	254 800	252 800	250 700	248 400	246 000
		t_m(°C)	—10.3	—9.4	—8.4	—7.4	—6.4	—5.3
	—	P_e (kW)	99.6	108.5	117.7	127.3	137.2	147.2
	0		208 600	206 900	205 100	203 200	201 200	—
	5	Q_o	204 300	202 700	200 900	199 000	197 000	—
—35	10	(kcal/h)	200 200	198 500	196 800	195 000	193 000	—
		t_m(°C)	—15.5	—14.6	—13.6	—12.5	—11.4	—
	—	P_e (kW)	89.6	97.2	105.1	113.0	121.1	—
	0		160 700	159 200	157 600	155 800	—	—
	5	Q_o	157 300	155 800	154 200	152 500	—	—
—40	10	(kcal/h)	154 000	152 600	151 000	149 400	—	—
		t_m(°C)	—20.6	—19.6	—18.5	—17.4	—	—
	—	P_e (kW)	79.8	86.1	92.4	98.7	—	—
	0		121 100	119 900	118 600	—	—	—
	5	Q_o	118 300	117 200	115 900	—	—	—
—45	10	(kcal/h)	115 900	114 800	113 500	—	—	—
		t_m(°C)	—25.6	—24.5	—23.3	—	—	—
	—	P_e (kW)	69.8	74.7	79.5	—	—	—
	0		90 100	89 000	—	—	—	—
	5	Q_o	88 200	87 000	—	—	—	—
—50	10	(kcal/h)	86 300	85 200	—	—	—	—
		t_m(°C)	—30.2	—29.0	—	—	—	—
	—	P_e (kW)	60.0	63.5	—	—	—	—
	0		—	—	—	—	—	—
	5	Q_o	—	—	—	—	—	—
—55	10	(kcal/h)	—	—	—	—	—	—
		t_m(°C)	—	—	—	—	—	—
	—	P_e (kW)	—	—	—	—	—	—

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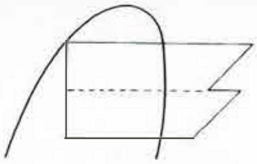

GRASSO

RC 8411

Two-stage, system A

n = 1000 rpm

↓ t_o(°C)	↓ Δt_o(K)	$\vec{t_c}$(°C)	+20	+25	+30	+35	+40	+45
—25	5	Q_o	324 400	312 400	300 100	287 700	274 900	262 000
	15	(kcal/h)	321 600	310 100	298 200	286 300	274 100	261 600
	—	t_m(°C)	—2.6	—2.1	—1.6	—1.1	—0.5	+0.2
		P_e (kW)	140.8	148.7	157.2	166.1	175.4	185.2
—30	5	Q_o	263 200	253 300	243 100	232 800	222 300	211 500
	15	(kcal/h)	260 800	251 300	241 400	231 600	221 400	211 200
	—	t_m(°C)	—8.0	—7.5	—6.9	—6.3	—5.7	—5.0
		P_e (kW)	126.0	133.4	141.2	149.4	158.0	166.8
—35	5	Q_o	211 400	203 200	194 900	186 500	177 800	169 000
	15	(kcal/h)	209 400	201 600	193 600	185 500	177 200	168 700
	—	t_m(°C)	—13.3	—12.7	—12.1	—11.5	—10.7	—10.0
		P_e (kW)	112.9	119.7	126.8	134.1	141.6	149.3
—40	5	Q_o	168 000	161 300	154 400	147 600	140 500	133 400
	15	(kcal/h)	166 400	160 000	153 400	146 800	140 000	133 100
	—	t_m(°C)	—18.5	—17.9	—17.1	—16.4	—15.5	—14.7
		P_e (kW)	100.8	107.0	113.3	119.8	126.4	132.9
—45	5	Q_o	132 000	126 600	121 100	115 500	109 800	104 000
	15	(kcal/h)	130 700	125 600	120 300	114 900	109 400	103 800
	—	t_m(°C)	—23.7	—23.0	—22.2	—21.4	—20.4	—19.4
		P_e (kW)	89.5	94.8	100.2	105.5	110.8	116.0
—50	5	Q_o	102 400	98 100	93 600	89 200	84 600	80 000
	15	(kcal/h)	101 400	97 200	92 900	88 700	84 300	79 800
	—	t_m(°C)	—28.6	—27.8	—26.9	—25.9	—24.9	—23.8
		P_e (kW)	79.1	83.5	87.8	91.9	95.8	99.4
—55	5	Q_o	78 300	74 800	71 300	67 800	64 100	60 500
	15	(kcal/h)	77 500	74 200	70 800	67 400	63 900	60 300
	—	t_m(°C)	—33.3	—32.4	—31.4	—30.3	—29.1	—27.9
		P_e (kW)	69.1	72.4	75.5	78.3	80.8	82.9
—60	5	Q_o	58 800	56 100	53 300	50 500	—	—
	15	(kcal/h)	58 200	55 600	52 900	50 200	—	—
	—	t_m(°C)	—37.7	—36.7	—35.5	—34.3	—	—
		P_e (kW)	59.2	61.3	63.2	64.6	—	—