PURPOSE

Test purpose is the measure of the following compressor operating parameters:

- flow of gas handled
- pressure rise produced
- shaft power requirement
- efficiency
- surge limit

STANDARDS

Test equipment, instruments, instruments calibration and procedures are in conformity with ASME PTC 10 Compressors and Exhauster Power Test Code 1965 Edition &Reaffirmed 1979 And 1986

INSTRUMENTS

The following parameters are continuously taken by a computerized system activating the related instruments:

- barometric pressure (JUMO 4 ABI 55 &range 95 to 105 kPa a)
- ambient temperature (CORECI HUMICOR 310 &range 0 to 50 °C)
- relative humidity (CORECI HUMICOR 310 &range 0 to 95%)
- inlet pressure (ROSEMOUNT 1151 DP-2 &range 0 to 1 kPa r)
- outlet pressure (ROSEMOUNT 1151 DP-4 &range 0 to 37 kPa r)
- upstream nozzle pressure (ROSEMOUNT 1151 DP-4 &range 0 to 37 kPa r)
- downstream nozzle pressure (ROSEMOUNT 1151 DP-4 &range 0 to 37 kPa r)
- inlet temperature (PT100 Class A + JUMO PDRw-48m/IA010)
- outlet temperature (PT100 Class A + JUMO PDRw-48m/IA010)
- upstream nozzle temperature (PT100 Class A + JUMO PDRw-48m/IA010)
- rotational speed, blower shaft power transducer (HONEYWELL FE7B + frequency meter A3 FV36 39)
- (SOCOMECE IME CW2 Class 0,5 &380V &5 A)
Instruments listed under 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 12 have been certified by M.A.E (independent inspection company) on 10.06.1999. Copy of certification is attached to test results. Instruments connection are shown in attached drawing n° 529.

**ADDITIONAL READINGS**

During performance test MECHANICAL RUNNING TEST is also performed. Therefore a set of bearing housing vibration readings and a set of bearing temperature readings are also taken.

Bearing housing vibration is taken on both housings in the VERTICAL, HORIZONTAL and AXIAL directions by means of a REUTLINGER MINISELECT n°9841f1c32 02-8.420.93002 analyzer, certified on 22.06.1998.

Bearing temperatures are taken on the outer rings by means of PT100 Class A probes certified on 10.06.1999.

Copy of instrument certifications is attached to MECHANICAL RUNNING TEST results.

**CALIBRATION OF INSTRUMENTS**

Per ASME specification calibration of all instruments can be carried on before running the test and once the test is over. A printed calibration log sheet is made available showing date and time, readings before and after calibration, entity of correction, entity of deviation.

Calibration is made against the following reference instruments:

- thermometer, mercury & range 10 to +50°C certified
- thermometer, mercury & range +50 to +100°C certified
- thermometer, mercury & range +100 to +150°C certified
- U type mercury pressure gauges
- Stroboscopic lamp BRUEL & KIAER certified
FLOW MEASUREMENTS

Flow measurements are achieved by means of long radius-low ratio nozzles mounted inside a metering pipe. Flow nozzles have been manufactured by Continental Industrie S.A. according to ASME specifications. A certified drawing of the flow nozzle/nozzles used for a performance test is attached to the test results. Also metering pipes have been manufactured in accordance with the ASME specifications and a certified drawing of the metering pipe used is attached to the test results.

Flow variation is achieved by different throttling of a butterfly valve installed downstream the flow nozzle.

Flow measurement is based on the followings:

- thermodynamic state of the fluid based on atmospheric pressure, ambient temperature and relative humidity (Molecular Weight and specific heats)
- differential pressure across the flow nozzle
- temperature upstream the flow nozzle
- nozzle discharge coefficient (depending upon the Beta ratio and the Reynolds number)
- thermal expansion factor for fluid meter
- expansion factor for flow nozzle

PRESSURE MEASUREMENTS

Pressure measurements are continuously and automatically taken by means of the pressure transmitters listed above and are directly used for calculations.

TEMPERATURE MEASUREMENTS

Temperature measurements are continuously and automatically taken by means of the temperature probes listed above and are directly used for calculations.
ROTATIONAL SPEED MEASUREMENTS

Blower shaft rotational speed measurements are continuously and automatically taken by means of the transducer described above and are directly used for calculations.

POWER MEASUREMENTS

Blower shaft power measurement is made possible by use of a set of certified test motors. Motor test certification has been obtained directly by motor manufacturer and shows motor efficiency Vs. input power. The certification of the motor used is attached to test results.

Input power to motor readings are continuously and automatically taken by means three current transformers (one on each phase) and a power converter as described above.

FLUCTUATIONS OF READINGS

According to ASME recommendations during test readings fluctuation is kept within the following limits:

- inlet pressure, absolute: 2%
- inlet temperature, absolute: 0.5%
- discharge pressure, absolute: 2%
- nozzle differential pressure: 2%
- temperature upstream nozzle, absolute: 0.5%
- rotational speed, blower shaft: 0.5%
- power, input to electric motor: 1%

COMPUTATION OF TEST RESULTS

Computation of test results is made in accordance to ASME Power Test Code specifications and includes a complete evaluation of each point as taken at test conditions, a complete evaluation of same point adjusted to standard conditions (typically 101,325 kPa a / 20°C / 36% R.H. / 2.970 rpm) and a complete evaluation of same
point adjusted to the jobsite conditions (as stated in the purchase order).
Test results of each point are printed in a sheet including Test conditions, Standard
conditions and Jobsite conditions.

Symbols used within this sheet are explained hereunder:

\[ \begin{align*}
\text{a1} & = \text{acoustic velocity - inlet} \\
\text{b2} & = \text{width - first impeller outlet} \\
\text{C} & = \text{coefficient of discharge - orifice} \\
\text{Cp1} & = \text{specific heat at constant pressure - inlet} \\
\text{Cp2} & = \text{specific heat at constant pressure - discharge} \\
\text{D} & = \text{inside diameter - metering pipe} \\
\text{d} & = \text{inside diameter - orifice} \\
\text{DH} & = \text{dissipated heat - compressor casing to ambient} \\
\text{D2} & = \text{outside diameter - first impeller} \\
\text{E.T.} & = \text{elapsed time (time per tested point)} \\
\text{Fa} & = \text{thermal expansion factor - aluminum orifice} \\
\text{His} & = \text{isentropic head (specific work, isentropic)} \\
\text{Hp} & = \text{polytropic head (specific work, polytropic)} \\
\text{k1} & = \frac{\text{Cp}}{\text{Cv}} - \text{inlet} \\
\text{k1n} & = \frac{\text{Cp}}{\text{Cv}} - \text{upstream orifice} \\
\text{k2} & = \frac{\text{Cp}}{\text{Cv}} - \text{discharge} \\
\text{m} & = \text{flow - mass} \\
\text{MW} & = \text{molecular weight} \\
\text{N} & = \text{rotational speed - compressor} \\
\text{Pbar} & = \text{pressure - barometric (ambient)} \\
\text{P1} & = \text{static pressure - inlet (inlet flange)} \\
\text{p1n} & = \text{static pressure - upstream orifice} \\
\text{P2} & = \text{static pressure - discharge} \\
\text{p2n} & = \text{static pressure - downstream orifice} \\
\text{PWRg} & = \text{power - gas} \\
\text{PWRs} & = \text{power - motor shaft}
\end{align*} \]
Q1 = flow - inlet (inlet flange)
R = gas constant
Ren = Reynolds number - orifice
rp = compression ratio
RH = relative humidity (ambient)
SH = specific humidity
t = temperature (ambient)
t1 = temperature - inlet (inlet flange)
t2 = temperature - discharge
t1n = temperature - upstream orifice
v1 = specific volume - inlet flange
v1n = specific volume - upstream orifice
z1 = compressibility factor - inlet
z2 = compressibility factor - discharge
z1n = compressibility factor - upstream orifice
\( \mu \) = absolute viscosity - inlet
\( \mu_n \) = absolute viscosity - upstream orifice
(md) = efficiency - mechanical, drive
(is) = efficiency - isentropic
(mc) = efficiency - mechanical, compressor
(p) = efficiency - polytropic
(gm) = efficiency - global, motor