Testing of Small Capacity Refrigeration Compressor on Air

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THE article presents one of the simple and quick tests for the testing of small capacity compressors. This method is found useful particularly where mass production of relatively few fixed types of compressors is undertaken.

INTRODUCTION

The purpose of this type of testing is to determine if the compressor is mechanically sound, has rated capacity and operates relatively quiet.

The standard methods, prescribed by the American Standards or British Standards, require the compressor to be connected in normal refrigerating cycle with elaborate ancillary equipment. Such tests are of course essential as type tests but as far as routine tests on mass production are concerned these become elaborate and are not feasible.

The method described here-under is for routine testing of refrigeration compressor by operating it on air for a very short duration. This type of test gives the relative performance of the compressors of the same category.

The necessary equipment for this type of test consists of two indentical receivers with suitable shut off valves at the inlets and outlets and pressure gauges with proper ranges.

SELECTION OF THE RECEIVER

As it is not desirable to run the refrigeration compressor on air for a long duration, the selection of the receiver capacity is to be done for an operating period of 60 to 90 seconds only during which the compressor would be pumping air to the receiver.

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The following assumptions are made for calculating the receiver capacity :

1. Swept volume of compressor : Vs m³/hr at the rpm at which test is to be conducted.
2. Average volumetric efficiency : 70%
3. The duration of the test : 1 minute.

The weight of air can be calculated by using the formula PV = WRT.

$$\therefore WRTa = \frac{1.033 \times 10^4 \times 0.7 \times Vs}{60}$$

Where Ta = ambient temp.
R = Gas constant for Air

The remaining symbols have their usual meaning.

$$\therefore W(Kg/min.) = \frac{1.033 \times 10^4 \times 0.7 \times Vs}{60 \times RTa} \quad \ldots\ldots\ldots (1)$$

Assuming that the receiver has volume Xm³, the weight of air inside the receiver at an ambient temperature Ta and a standard atmospheric pressure would be $W_1 = \frac{PV}{RTa} = \frac{1.033 \times 10^4 \times X}{RTa}$ kg

The final pressure inside the receiver is taken as 7 Kg/Cm² gauge (at which the compressor would be stopped).

Therefore, the weight of air at pressure = 8.033 Kg/Cm² absolute (assuming that the temperature of air inside the receiver remains the same as Ta,) would be

$$W_2 = \frac{8.033 \times 10^4 \times X}{RTa} \text{ Kg}$$

$\therefore$ Weight of air pumped in the receiver per minute should be

$$(W_2 - W_1) = \frac{7 \times 10^4 \times X}{RTa} \text{ Kg/min.} \quad \ldots\ldots\ldots (2)$$

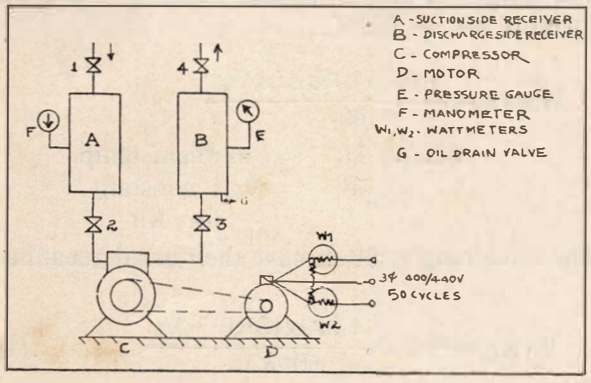
Therefore, the capacity of the receiver required so as to be filled with the compressor having swept volume as Vs m³/hr within one minute would be obtained by equating (1) and (2)

$$\text{Thus,} \quad \frac{7 \times 10^4 \times X}{RTa} = \frac{1.033 \times 10^4 \times 0.7 \times Vs}{60 \times R \times Ta}$$

$$\therefore \quad X = \frac{1.033 \times 0.7 \times Vs}{60 \times 7} = 0.00172 \text{ Vs m}^3.$$

EXPERIMENTAL PROCEDURE

Connect the refrigeration compressor to two identical receivers having the approximate capacity calculated from above, as shown in the diagram.



Testing for Noise Level

Operate the compressor keeping all valves open except the oil drain valve and listen for unusual noise or knock. If there are no abnormal noises, it means that the compressor is assembled correctly and is mechanically sound.

Test for Vacuum

The valve Nos. 3, 4 and 2 are kept open, valve No. 1 is closed, and the compressor is started. When the maximum vacuum is built in the receiver which can be noted accurately from monometer F, the compressor is stopped. If there is any leakage past the discharge valve, the vacuum breaks.

Thus this testing indicates the leakeback test and the maximum vacuum the compressor can build.

Pressure Test

Valve Nos. 1, 2 and 3 are kept open and valve No. 4 is closed. The compressor is started and is allowed to discharge the air into the receiver B. The time required to build up the pressure upto 7 Kg/Cm² gauge is noted with the help of stop-watch. Three such readings are taken and the mean of these obtained.

If a large number of compressors of the same capacity are tested with this type of test, the average time taken by each compressor should remain constant. If a particular compressor takes more time than the average, the compressor may be sent for reinspection. The power consumed by the motor is also noted down at various pressures with the help of wattmeters.

Testing for internal Leakages

The compressor after building up the required pressure is stopped and the pressure drop is observed for the first five minutes.

During the first minute, the drop of pressure would be more, say upto 0.3 to 0.4 Kg/Cm². Then for the next 4 minutes it should not exceed 0.5 Kg/Cm².

The oil requires frequent draining from the discharge receiver (one or two times a day).

CONCLUSIONS

The above mentioned test only indicates comparative performance of the compressors of the same series and should not be taken as an absolute measure of capacity because of the following reasons :

1. The temperature assumed is constant throughout the operation. The actual observations indicate that the temperature of air inside the receiver increases continuously due to addition of heat of compression. As the duration of the test is extremely small, and the ratio of compression is changing at every instant, it is

rather difficult to determine an average air temperature.

2. The volumetric efficiency is assumed to be constant whereas in actual practice while pumping, the ratio of compression increases from 1 to 8 and as a result the volumetric efficiency decreases.

3. The pressure in the vessel rapidly increases in the beginning and more slowly afterwards.

4. Out of the total time required for building the pressure, the compressor will run relatively long with a high pressure ratio.

5. At the starting of the day while testing the first compressor, the temperature of air inside the receiver is fairly low and goes on increasing as the number of compressors tested increases. This can be avoided by allowing the receiver to cool down to ambient conditions. This however would reduce the number of compressors to be tested per day.

To carry out more accurate capacity measurement, the compressor is started first and when the pressure has attained 2 or 3 ata, measuring can be commenced. The time reading is taken for building a pressure of 4 ata, 5 ata, 6 ata and so on. The capacity then is calculated at average values of pressures at $3\frac{1}{2}$ ata, $4\frac{1}{2}$ ata, $5\frac{1}{2}$ ata, etc. Thus the $\triangle$ P is always 1. With this method, capacities can be calculated within an accuracy of $\pm 5\%$.

REFERENCES

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