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Graphical representation of compressed air formulae

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GRAPHICAL REPRESENTATION OF COMPRESSED AIR FORMULAE.

Introduction.

Compressed air has been in use for some time, although it is only in the last few years that its application as an agent for transmitting power has been extensive.

It is now put to a variety of uses; such as pumping, ventilating mines, the operation of drills and other stone working machinery in addition to other uses too numerous to mention.

Out

Air during compression and expansion obeys the same laws as do other gases and these laws have been mathematically stated by purely rational formulae. ~~Almost any~~ Most of these formulae are logarithmic ~~ones~~ and their use ~~in these forms~~ involve~~s~~ a considerable amount of work.

The object of this thesis is to present these formulae in such form that problems involving their use may be readily and easily solved. It was decided to present them graphically and the accompanying curves are the results of our labors.

Explanation of the uses of the accompanying curves.

CURVE 1.

This curve shows the relation between the ratio of compression and the efficience of a motor when using air without expansion, as given by the formula- E ~~R=~~R-I+R LogR. $E = R - 1 \div R \log R$ Say it is desired to know at what efficiency a motor will run that uses air that has been compressed to six (6) atmospheres. On the right hand side of the sheet look on the margin for six (6), follow the horizontal line until it intersects the curve; now follow the vertical line through the above mentioned intersection down to the bottom of the sheet and read 46.5 %. This is the theoretical efficiency at which the motor will operate under the above mentioned conditions.

CURVE 2.

These curves show the relation between the ratio of expansion and the work that one pound of air can do by expanding isothermally or adiabatically. They also show the advantage of using adiabatic expansion as it gives greater work for the same pressure.

There are two curves for adiabatic expansion; one showing the work of the theoretical expansion and the other showing the work as it is generally obtained in practice. The curves at the top of the sheet on the isothermic are drawn to a large scale so that accurate values may be scaled off of them. To use the curve follow the same directions as given under curve number 1. Be careful to use the curve that has indicated upon it the initial temperature under which the air is used and remember that the work is for one pound of air.

CURVE 3.

This curve shows the relation between the weight of one cubic foot of air and the temperature and pressure as given by the formula

$W::-\frac{P}{53.2\,T}$ To Use the curves or straight lines, select the line that has indicated upon it the given temperature; at the bottom of the page find given pressure; follow the vertical line through this point until it intersects the line of the given temperature. Now follow the horizontal lines through this intersection to the margin and the weight may be read off. For any temperature the lines that are inclined to the left may be used, choosing the one upon which is indicated the given pressure.

CURVE 4.

This curve shows the relation between the friction loss in pressure, the diameter of the pipes, the velocity of the air passing through them and the ratio of compression. This formula , $F::.0000016 - \frac{l}{d}V^2\ R$ is the only one which takes into account the density of the air, and as the friction must certainly take into account and vary with the density, it is the most rational formula. Pipes larger than ~~three~~ nine inches are seldom used in compressed air plants so the curves are made only to include pipes up to 9 inches.

To use the curves, select the curve which has indicated upon it the diameter of the pipe to be used. These curves are drawn for value of R equals 4. Now proceed as per instructions under curve 1. For any value of R, other than 4, use the straight lines at sides to connect the values obtained from the curves.

CURVE 5.

These curves show the relation between the pressure, temperature and volume for adiabatic expansion according to the formula
To use the curves, select the line that has the given pressure or volume indicated upon it. Read off the values as explained in curvesnumber 1. If other values of pressure or volume are wanted, select one value and correct it by applying it to the other set of lines.

CURVE 6.

These curves show the relation between the pressure and volume for isothermal and adiabatic change and the relation existing between the two
The formulae are ; isothermal, P.V. :: C and adiabatic
To u e them use the same general method as previously outlined is to be followed.

CURVE 7.

This curve shows the relation between the pressure and the altitude and the loss in power and capacity of machines working at altitudes above sea level. The line showing the drop in pressure gives the variation of pressure with altitude. The one indicating the decrease in power required gives the percentage of decrease in power required to perform the work at various elevations and the one indicating the loss of capacity gives the percentage of loss of capacity that machine will suffer at the various altitudes. The decrease in pressure necessarily gives a decrease in capacity of machine. To use curves follow general instructions as given before.

CURVES 8 & 9.

These curves show the relation between the temperature, pressure and horse power per cubic foot of air used in compressor for one, two, three and four stage compression. They show the relation between the different styles and also the advantage of using multiple stage machines. They give greater horsepower for the amount of air. Let it be required to determine the horse power required to compress a certain number of cubic feet of free air to any gage pressure, using any of the multiple stage machines and the curve that has indicated upon it the desired stage of compression gives the required pressure, the correspondigg ordinate to the curve at that point will give the horse power required for the cubic focr of air. Then for any number of cubic feet, simply multiply the horse power f und by the number of cubic feet and the product is the horse power sought. The temperature at the end of the compression is given by the temperature curve. Find the gage pressure on the top temperature curve and the corresponding ordinate will be the final temperature. Of course this air is always inter cooled and this temperature im never obtained nor is it desired. The object of determining the temperature is to know how much water will be necessary to cool the air down to the desired temperature.

CONCLUSION.

The description of these curves is not complete as it should be, but, owing to unforeseen circumstances, our time was limited so that we had to be more brief than we wished to be. Nevertheless we think the description lengthy enough to give any one who will ever have occasion to ~~give~~ use them a fair understanding of their use and application. We intended to go furtherwith this subject than we have, but owing to lack of time we were compelled to omit some of the curves and present only the more important and most used ones.

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Respectfully submitted,