steam is given off. Now, we have water in a state of steam, which is visible to the eye. If we watch the cloud of steam as it rises upward, it will be noticed that it gradually gets thinner and thinner, until at last it disappears from view. What has become of it? We have produced the invisible water-vapor, and it has been absorbed by the air.

The change from steam to vapor took place like this. In a boiler it is the water which lies next the surface exposed to the fire that is first turned into steam. In order to do this the coal must transfer energy to the water to raise not only the atmospheric pressure, but also the pressure due to the depth of water in the boiler. Now when the particles of steam emerge from the surface of the water they are under a less pressure than when at bottom of the boiler, and so contain more heat than is necessary to keep them as steam. This surplus heat or energy causes an expansion or bursting of steam into the smaller particles, which constitutes water-vapor, which is absorbed by the atmosphere.

This last expansion is on the same principle as when we open a try cock below the water line on a working boiler, it is not water which blows out but steam or vapor. We will now sum up these two operations. In the first the heat or energy of the sun does work on the atmosphere, thus setting the air in circulation, and as a result of the air circulating water is absorbed. In the second the heat or energy of the coal does work on the atmosphere, setting free the steam, and at the same time storing in the particles steam and energy, which turns the steam into vapor when it rises into the air. From the above conclusions we see that evaporation, or nature's method of making water-vapor, and the making of steam at atmospheric pressure and its change into vapor, differ only in the two forces that produce them.

In reference to making steam in boilers there are two interesting cases besides the one which we have just discussed, namely, making steam under a pressure greater than the atmospheric pressure, and under a pressure less than the atmospheric pressure. Dealing with the first mentioned case, that is, where the pressure is greater than the atmospheric pressure; this condition can be brought about by fitting the steam-tight cover on the boiler mentioned in the first case and putting some weights on it to the amount of 5 lbs. per square inch. Now, instead of steam being given off when the water is at about 212° F., it will not be given off before the temperature is 226° F. This increase in temperature is due to the fact that before steam can form in this case the coal must transmit to the water enough of its energy to raise 19.7 lbs. per square inch instead of 14.7 as before. This condition of things comes about naturally when boiling water in mines, for as we descend into the earth the atmospheric pressure increases, which corresponds to the added weight.

Lastly and briefly we will consider the making of steam under a pressure less than the atmosphere at sea level. For this we would have to exhaust the air from our boiler by an air pump or other means. Then we would find that steam would be given off when the water is at a temperature less than 212° F., according to the amount by which the pressure in the boiler is less than atmospheric pressure. This shows that as there is less pressure keeping the parts together in this case than in the other two it therefore requires less energy to set the steam free. As an example of this in nature it has been noticed by travelers going up mountains that when they got high up it takes a much longer time to boil eggs than on the plain below, although the water in giving off steam went through the same action in both places. This was due to the fact that at the top of the mountain the pressure of the atmosphere was less than at the bottom, and the water though giving off steam did not contain the heat necessary to boil the eggs. I think if these travelers had been engineers they would have piled some stones on the lid of their kettle in order to save time.

In this case it is interesting to notice that although it requires less heat to raise steam at a high elevation than at the ordinary atmospheric pressure at the sea level we do not gain anything by reducing the pressure, because when we sum up the heat required to raise the steam, and the force required to reduce the pressure below the atmosphere, we will find that it will amount to the same thing as if we were making steam at atmospheric pressure.

OILS FOR THE ENGINE ROOM.*

BY JULIUS M. WILLIAMS, CHEMIST, HAMILTON.

This subject is considered as being important enough to justify considerable attention from engineers, and this paper being much appreciated by the local association, it is by their request read before the convention, and it being considered inconvenient to repeat the full text, it is condensed, and samples of oils and the products of their decomposition are for the same reason not shown. The matter is treated in the following divisions:

1. Relation to the machine, the prime object of oil is to reduce friction, consequent to the effort of the motive force to overcome the resistance of the weight, that is the work of the machine.

2. Nature of the material, fluid, capable of passing between tight fitting surfaces either voluntarily or by mechanical means, non-resisting, especially free from abrading particles, and from corrosive qualities.

3. Possessing sufficient viscosity and specific gravity to be of service; absence of viscosity and low specific gravity being in inverse relation to the strain or weight on the bearings.

4. Nature of the machine and its special conditions.—The points of friction usually called bearings, consisting of two close fitting surfaces, one or both moving, either rapidly or slowly.

The conditions being mainly that of temperature, this suggests the division of bearings into two kinds, hot and cold; cold bearings being considered first as being the earliest in use and embracing the largest number, these are exposed to a range of temperature extending from the average of 100° F. at the top of a room to that of winter weather outside; mechanical contrivances dispose of many of the difficulties met with on account of variations due to temperature.

Hot bearings are few and include cylinders, pistons and cut-offs.

5. The requirements or qualities of the oils to meet these conditions:—

They should be clean, free from abrading substances.

Non-resistant, free from resinous constituents.

Non-volatile, permanent, so that bearings will not "go dry."

Non-drying, free from "gumming" propensities.

Neutral, free from organic or mineral acids, the first due to rancidity, the second to the refining processes.

6. Hot bearings.—To meet the conditions of the very high temperatures of the principal hot bearing, the cylinder oils require to be of high stability and especially free from the substances before mentioned, that is, volatile, resinous, and decomposable ones, owing to the fact that fixed oils decompose at 600° F.; in the presence of steam with the production of fatty acids and glycerine it is evident that oils partly decomposed, rancid, are not desirable in a cylinder.

7. The constitutional nature of oils.—They are supplied by the three kingdoms, animal, vegetable and mineral.

The animal oils are of great variety and from many sources, the principal ones being the meat and fish trades; these include the various refuse handling sections of those trades, whence are supplied vast quantities of oil.

There may be enumerated here in the order in which they predominate the animals whose oils we use in this country: The hog, horse and cattle; of the fish, cod, whale, sperm whale, etc.

The vegetable oils will be familiar as olive, castor, cottonseed, earthnut (peanut), and are variously the product of seeds, nuts, fruit.

The mineral oils constitute by far the greatest part of the oils in use as lubricants, and are used alone or in combination with oils from the other two sources. Mineral oils possess in their wide range of varieties all the requisite qualities of good lubricants.

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Yours sincerely, E. ROCHESTER.

54 Rochester street, Ottawa, Aug. 16, 1898.

*A paper read before the C.A.S.E.