the sky is termed. The type developed by Abbot and Aldrich is described in Smithsonian Misc. Collections, vol. 66, No. 7, 1916, but the name would be suitable for Mr. Dines's instrument (*Meteorological Magazine*, vol. 55, p. 189, 1920); by analogy the Callendar radiograph, which gives a record of the heat carried by the luminous rays from sun and sky and received on a horizontal surface, should be a pyranograph.

Prof. Abbot measures the heat from the sun, and also the heat from the sun plus the heat from the sky within 15° of the sun with one of these instruments, and by applying appropriate factors obtains the "solar constant." Mr. Knox-Shaw has examined a series of observations made at Calama in Chile and reduced by Prof. Abbot's staff by this method. He finds that they show no correlation between the computed values of the solar constant and the transmission coefficient. It is to be hoped that the validity of this new method will be confirmed, as it will make the regular determination of the strength of solar radiation practicable at many stations where the more elaborate routine could not be adopted. At Helwan the sun is to be observed with the Ångström apparatus once a day at a specified altitude. For the application of Abbot's method the Ångström readings will have to be supplemented by those of a pyranometer.

Natural Gas Gasoline.

THE PRODUCTION OF LIGHT OILS FROM NATURAL GAS.

By H. B. MILNER.

NATURAL gas may be of two distinct types—dry gas or wet gas. The former consists essentially of methane, with practically no other members of the paraffin series, the latter being composed of methane with varying amounts of ethane, pentane, hexane, and heptane, and certain dilutants such as nitrogen, carbon dioxide, carbon monoxide, sulphuretted hydrogen, and sometimes helium. Dry gas is normally associated with coal or decomposing vegetable matter and is rarely met with in the presence of petroleum; wet gas, on the other hand, is essentially the gas present in oil pools, either in the free state or dissolved in the oil under pressure.

The production of natural gas gasoline—as it is called—constitutes a comparatively recent development of the petroleum industry, particularly in the United States. The gas employed for this purpose is that which so frequently accumulates in the top of oil-well casings, or which, under pressure varying from a few to several hundred pounds, is forced along the flow lines leading from the casing head. Composed of lower members of the paraffin series than ordinary petrol obtained by refining crude oil, natural gas gasoline is far more volatile and inflammable, and therefore its use *per se* is normally inadmissible. But mixed with some of the heavier fractions derived from crude oil, it forms a fuel ranging from 0·660 to 0·750 in gravity, in all respects suitable for internal combustion engines of the automobile type.

There are three recognised processes for extracting oil from natural gas—the compression process, the absorption process, and the combined compression and absorption system. The compression process consists in the liquefaction by pressure and refrigeration of the heavier paraffins present in the gas, and is usually employed where the initial density of the gas exceeds 0·8, *i.e.* where the gas is rich in the heavier hydrocarbons. The plant employed entails a compressor, condensing or cooling coils and collecting tanks. The average yield of oil by this process is 2·5 gallons per m. cubic feet; 73 per cent. of the output of natural gas gasoline for 1920 in the United States was produced by the compression process.[1]

The absorption process has the advantage that it is applicable to "lean" gas, *i.e.* gas yielding anything from 0·1 to 0·5 gallons per m. cubic feet, and by this process much so-called dry gas has been utilised which would otherwise have been wasted, being of too low a grade to be treated profitably by the compression process. The absorption system necessitates passing the gas through an oil of higher gravity than ordinary petrol, from which it is recoverable by fractional distillation. The combination process is a more recent development, whereby the gas is compressed under low pressure to a smaller volume, then absorbed by seal oil and subsequently recovered by distillation. This process has been employed recently by pipe-line companies in the United States to recover gasoline from low grade wet gas accumulated in gas distributing lines. The average yield of oil by the absorption process is 0·2 gallons per m. cubic feet.

The principal States in America producing natural gas gasoline are Oklahoma, West Virginia, California, and Texas, besides eight other States giving a subordinate output. The bulk of the products is sent to the northern States and California, where in the latter case the oil is mixed with petrol obtained from low grade crude oils. Much of the Canadian natural gas gasoline is being blended with petrol obtained from Mexican crude oil, and in this way, also, many oil wells which would otherwise be derelict are, by their yield of low grade wet gas, giving good results, quite apart from the better known and more valuable gas wells.

Some idea of the remarkable growth of the industry in America can be gauged from the fact that whereas only 7½ million gallons of gas gasoline were produced in 1911, nearly 400 million gallons were produced in 1920. This constitutes more than 7 per cent. of the total production of gasoline in the United States for that year.

Quite apart from any statistical evidence, it is clear that this new industry now firmly established in America will, by its steady progress, have a far-reaching consequence on the available supplies of fuel-oil for world consumption in the future. Many fields which have hitherto been poor producers may quite conceivably be rendered sound from a commercial standpoint by the utilisation of the natural gas now allowed to run to waste. In such countries as Russia, Persia, Burma, Egypt, and Trinidad, the processes are, by reason of the large quantities of natural gas available, especially applicable, though little, if anything, has so far been done in this direction. Wherever natural gas can be controlled at the casing head, the possibility of its treatment for the recovery of light oil should be taken into account. In the fields cited above, especially in Trinidad, the value of such recovery lies not so much in the actual production of petrol, but in the enhanced value attained by low grade crude oil fractions as a result of careful mixing.

[1] "Natural Gas Gasoline in 1920," by E. G. Sievers. Min. Res. Unit. States, 1920, Part II., pp. 289-300. (Unit. States Geol. Survey.)