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Gas and fuel testing methods and apparatus developed at the Institute of Technologie of fuels at the Technical University of Vienna.

Until 1920 the Technical University of Vienna included a regular Faculty of Technical Chemistry only. In 1920 a "Special Branch for Technologie of Combustion and Gas" was created by Prof. Hugo Strache, the inventor of the Strache-watergas process, the Strache-doublegas process and owner of about 90 patents. The new kind of education had nothing equal until 1938, when Prof. Karl Bunte founded a similar educational branch at the Technical University of Karlsruhe, Germany.

The aim is the education of engineers for research and practice with special knowledge on the fields of mechanical, thermal and chemical refining of coals, preferably refining by gasification, and of combustion processes of coals, and a general knowledge on both, Chemistry and Mechanical Engineering.

The main lecture on "Technologie of fuel" is paralleled by laboratory work and technical calculations on the same stuff. In the laboratories the technique of developing new processes and apparatus is chiefly exercised. In order to become M. S. and Ph. D. Engr., research work consists generally in a practical performance of any coal refining process, gas process, or heat transfer theme, whereby students and M. S. are obliged to design and construct the apparatus used for their task.

In the following an extract is given of the special testing methods and apparatus developed in these laboratories at which I have been for 19 years as a first assistant, lecturer and finally deputy director.

1. The steam-decomposion meter was developed in connection with the invention of the Strache-watergas process which brought forth progress in the manufacture of watergas using optimum temperatures in the fuel bed and shortening the cycles and changing the proportions of blow and run. The principle of the steam-decomposion meter is the comparison of the produced watergas volume with the steam volume introduced into the generator. With the decreasing temperature and therefore decreasing steam decomposion the developed gas volume becomes smaller, according to the equation $C + H_2O = CO + H_2$ and a signal given by the apparatus indicates the end of the economic steam run.

2. The "Autolysator" of Strache was used for measuring the carbon-dioxide content of the blow gases. The function is given in the continuous flow of a gas sample through a capillary tube, a carbon dioxide dry absorber and another capillary tube. By maintaining a constant gas volocity and therefore a constant pressure loss at the first capillary tube, the pressure loss of the second capillary tube is proportionate to the carbon dioxide content of the gas.

3. The Strache - "Siccus" carbon dioxide indicator is a small portable apparatus especially designed for the analysis of flue gases. The bore of a relatively large metal stop cock presents the gas measure space and contains a pump with which after turning it in proper position, the gas is

pressed through the chamber with the dry absorbing agents. The reduction of the pressure in the system is indicated by a petroleum manometer.

4. The "Carboscope" is much smaller and more reliable than the "Siccus" and needs a gas sample of but 5 ml which is trapped in a partial space of the bore of a metal body in which, after sampling, a piston containing the dry absorbing agents, is moved. The pressure acts on a membrane and its movement indicates the percentage of carbon dioxide. A combination with the determination of carbon monoxide is developed too, but is not yet ready for market.

5. The "Quintex" - Orsat apparatus with three absorption pipettes and a platinum tube heated by a gasoline lamp is a convenient apparatus for the analysis of flue gases and measuring of CO_2, O_2 and small amounts of CO, H_2 and CH_4. The apparatus has a diameter of 6.5" and a height of 12".

6. Other gas analysis apparatus were developed and used in my laboratories only. For the rapid, precise analysis of watergas containing CO_2, O_2, CO, H_2, N_2 and small amounts of CH_4, the determination of CO, H_2 and CH_4 together by explosion in oxygen atmosphere was used and the complete gas analysis made in about 15 to 20 minutes.

An automatically working apparatus determined the nitrogen content of combustible gases by burning the combustible constituents, absorbing the developed CO_2 and indicating the nitrogen content by the remaining partial pressure.

7. With the "Vaporoscope" the steam content of producer gases can be determined in a quick and convenient manner whereby the tar and dust content of the gas does not hamper the determination. The simple apparatus consists in a cylindric metal body which is introduced into the gas outlet pipe of the producer. After having measured the gas temperature at the sampling place the body is then placed in water which is sucked in by contraction due to the temperature decrease and due to the contraction caused by water steam condensation.

8. The modified Junkers-type gas calorimeter employs a 20 liters aspirator bottle with tubulators instead of the normally used wet gas meter, the pressure regulator and the weighing device. The heated water leaving the calorimeter is introduced into the aspirator bottle and displaces the gas to be burned in the calorimetric Bunsen burner. As the employed gas volume is equal to the heated water volume the increase in temperature of the calorimeter water is equal to the thermal value of the gas divided by 1000.

9. The "Strache-Explosion-gas-calorimeter" for the determination of the "gas value number", that is, the product of the thermal value of the gas and the gas volume liberated by carbonization and gasification processes. The entire gas volume developed in the microcarbonization test method described under item 15 can be pumped into the explosion glass pipette by means of air. The explosion pipette is surrounded by an air jacket. The air in it is of atmospheric pressure and extends after firing the gas air mixture. The extension is measured by a petroleum manometer. This apparatus is sensitive and is used in a few laboratories only. The gas measuring device of it is a

clever one, as the gas measure pipette is mounted in a water filled glass tube together with an air filled pipette of the same size but closed at the top. By adjusting an equal mercury level in both of the pipettes the gas sample is equal to the hydrogen gas sample used for gaging, so that no correction is necessary for barometric pressure, room temperature and moisture content of the gas.

10. The gas thermal value meter "Caloriscope" is widely spread as it gives relatively quick and precise results. It consists of a ball shaped glass explosion pipette with a vacuum jacket and a large mercury thermometer bulb in the centre, the latter representing both the calorimetric and the thermometric body. The apparatus is equipped with gas measure pipettes of different sizes for the investigation of gases of different thermal value range.

11. The "Strache-Löffler" Microcalorimeter works in its principle similar to the Caloriscope but permits the use of smaller volumes of gas and to adjust each desired proportion of gas and air. Mercury is used as sealing liquid whereas the caloriscope is operated with water.

12. For the determination of the combustion velocity of gases, such as producer gas, water gas and coke oven gas and various detoxicated consumer gases, an apparatus was constructed and used, with which the combustion velocity curves were measured with continuously varying air gas composition in one short test run. The results were well reproducible due to the possibility of adjusting optimum shapes of the measure flame cones by means of three detachable burner tubes of different diameter and due to the possibility of varying the mixture velocity through the ports of these tubes.

13. The "Gasfinder Rapid" is used to find out leaks of gas pipe lines. The gas enters the chamber of the apparatus by diffusion through a semi-permeable wall and acts on a membrane which moves a hand indicating the percentage of gas in the air.

14. The "Expo" extrapolation pyrometer was developed for the exact determination of the real gas temperature by means of three non-protected thermocouples of different wire diameters. The real gas temperature is found by extrapolation of three readings to the wire diameter zero. By this method flame temperatures up to 2100°C were measured with platinum thermocouples melting at 1770°C. Measuring flue gases in boiler plants with usual relative low gas velocities by means of mercury thermometers and thermocouples in protecting tubes, apparent gas temperatures were found 10 to 20 per cent below the real gas temperature. The divergences between apparent and real gas temperatures were less when testing boiler plants with higher gas velocities.

15. With the Strache-Hiller carbonization method coke, tar and gas is determined using a micro apparatus with 0.1 g of coal sample. The yields of tar and the gas value number are well comparable with yields of commercial plants and well reproducible. The apparatus consists in a properly bent resistant hard glass tube. The part with the sample is heated. The cooled part traps carbonization water and tar and is connected by a

22. For the approximate and rapid determination of the heat conductivity coefficient of fire bricks and insulating materials a method was developed, which gives results in 20 to 30 minutes using the law of temperature rise at a fixed point in the interior of a brick after suddenly having heated up the surface to a determinate temperature.

23. In laboratory practice the admixing of a definite amount of water vapors to a gas flow in order to obtain a desired determinate saturation is asked relatively often. Most of the laboratory vaporization devices known by publications or used in other research laboratories were proved in my laboratory with the result, that there is no ideal saturator giving a hundred percentage saturation for the usual saturation temperatures and for a large gas velocity interval of, for example, 0 to 500 liters per hour.

About 15 apparatus employing different principles and arrangements were constructed and investigated in laboratory experiments. One of these types using four ring shaped glass tubings above each other and placed in a thermostat gave well reproducible saturation curves employing 0 to 275 liters gas per hour at saturation temperatures from 30 to 85°C and a relative low pressure loss.

The so-called "adiabatic flash" represents a small laboratory boiler yielding a constant vapor flow at a constant electric heat when using a capillary tube as steam outlet. This device gives constant vapor flows of about $\pm$ 5% precision. Investigations and improvements with this type were made in order to obtain more satisfactory results.

Almost all of the preceding briefly described methods and apparatus for testing fuels are published in several European periodicals on the field of coal, gas and apparatus technique and in the textbook of "Technologie of Fuels" by W. J. Mueller and E. G. Graf, 2nd and 3d editions, Vienna, F. Deuticke, 1945.

It is assumed by the writer that some of the described methods and apparatus should be of use and interest to the American fuel and apparatus industry too.

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