"PINTSCH" TAR RECOVERY FROM STEAM BOILER FURNACES

Recovery and utilization of tar as practised heretofore.--Description of a new process for tar recovery from steam boiler furnaces —t st results—efficiency of the process.

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The actual tar producing temperature lies between 300 and 500 degrees Centigrade. The tar recovered at these temperatures, without being exposed to higher temperatures, is called *low-temperature-tar*.

The chief characteristics are the presence of aliphatic and absolute lack of aromatic hydrocarbons, especially of benzole, naphthaline and anthracene. It contains oils which are classified as lubricating oil, gasoline, kerosene, phenoles, gas oil, paraffin and pitch. The oils have a certain likeness with the distillates derived from petroleum.

A tar of very different composition is obtained in gas works and coke ovens, because the low-temperature-tar, which is originally formed in those processes, is decomposed in the distillation-chambers on account of their high temperature. The tar recovered contains benzole, medium oil, heavy oil, anthracene oil, phenole, cresole, naphthaline, anthracene and pitch.

While the tar recovered from gas works and coke-ovens has been used for different chemical purposes since many decades, the importance of the low-temperature-tar has been acknowledged by the chemical industry only within about the last 10 years, next to the natural oil it is the principal raw material from which oil can be obtained.

This originated in most countries without natural oil resources the endeavour to extract the tar quite generally and especially low temperature tar from coal before using it definitely, without, however, materially increasing the consumption of coal. The method which first promised fair results was the producer method, and a large number of gas producers with low-temperature-tar recovery have been erected in recent years. With this kind of plants one gets a gas of about 165–370 B. T. U. and low-temperature-tar.

Another possibility to produce low-temperature-tar is the pure distillation method, which has been adopted in different types of apparatus like rotary drum, special kinds of chamber ovens a. s. o. In this kind of plants one obtains besides low-temperature-tar and a small quantity of a very rich gas, a great yield of *coalite*. Sometimes, there are great difficulties to dispose of this coalite as it is very brittle.

Large quantities of coal are burnt in the grates of stationary plants mostly for the production of steam and power. In Germany for instance, this method accounts for about 31% of the total coal consumption. Naturally the desire was growing to open up these plants for tar recovery. During the war, coal was carbonised in gas works and coke ovens to recover tar and ammonia, and the coke produced was burnt on the grates. However, this process is very uneconomical. Another process to recover tar from the coal used for the production of power is to gasify the fuel in gas producers with bye-product-recovery, whilst the gas is either burnt under the boilers or utilized in gas-engines. A number of such plants has been erected, but this arrangement did not find much favour owing to the somewhat complicated and not very economical equipment.

The desire to have a more economical and simple arrangement prompted the Julius Pintsch Aktiengesellschaft, Berlin to design their patented boiler furnace with low-temperature-tar recovery.

The Boiler Furnace with Low-Temperature Tar-Recovery

The first plant of this kind was supplied to the Municipal Power Station in Berlin Lichtenberg, and operated there for several months, until the complete power station was shut down.

In this case, the tar-recovery plant was supplied to a standard Steinmuller water-tube-boiler.

The only alterations made on the boiler were the following: The ordinary coal supply hoppers were replaced by distillation shafts and one gas burner was provided on each side of the boiler over the grate.

The chief dimensions of the boiler were:

Heating surface of boiler	497.3 sq. m. = 4,620 sq. feet.

Heating surface of superheater	154.3 sq m. = 1,440 sq. feet.
Heating surface of economizer	300.0 sq. m. = 2,790 sq. feet.
Grate area	17.0 sq. m. = 158 sq. feet.

The complete arrangement and the operation of the whole plant is illustrated in Figs. 1 to 4.

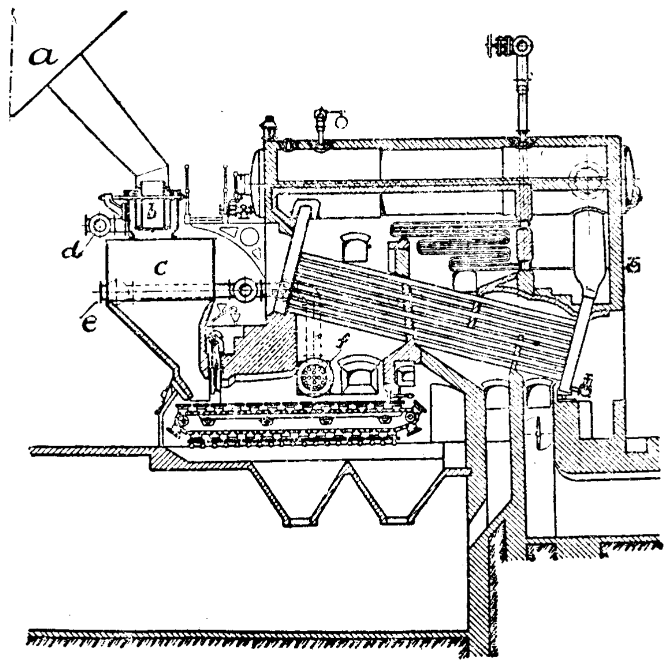

Fig. 1.

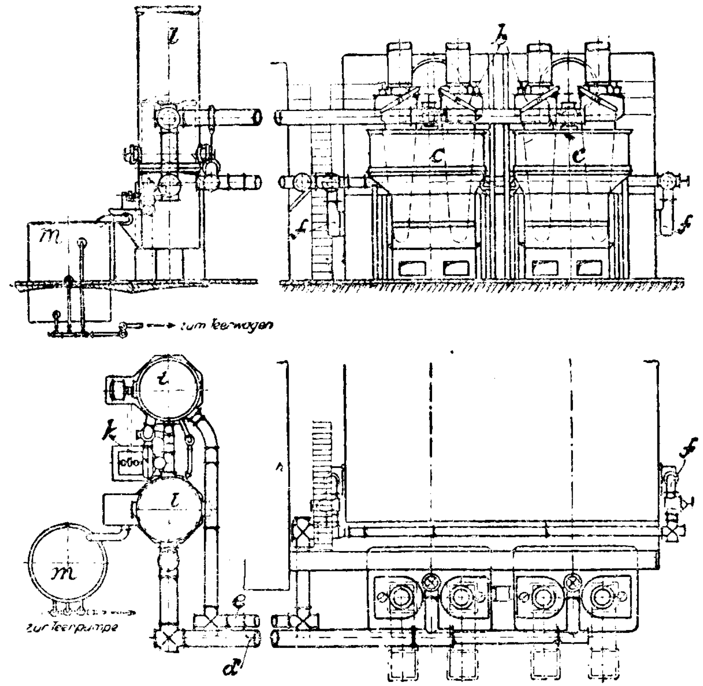

Fig. 2.

The fuel passes from the bunker *a*) through 4 hoppers *b*) to the 2 distillation shafts *c*) situated in front of the boiler over the mechanical chain grates. Whilst the fuel slowly glides down through the distillation shafts, one part of the hot combustion gases is sucked back from the combustion chamber and passes upwards through the fuel in the distillation shafts.

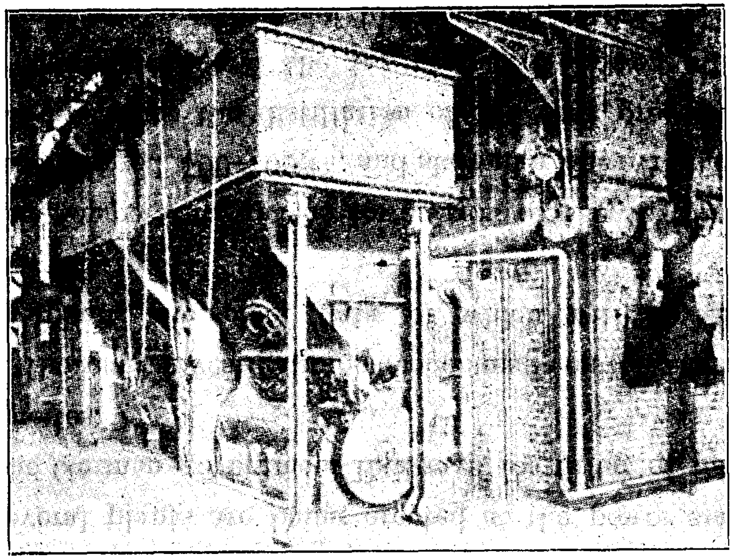

Fig. 3.

The gas which enters the bottom of the distillation shafts has a high temperature, and by giving off its sensible heat to the fuel, cool down itself, while the fuel is heated and so distilled. The distillation products (water vapours, tar vapours, permanent gases) mix with the combustion gases; both together leave the top of the distillation shafts through the outlet pipe *d*) with a temperature of about 100°C., and reach the tar separating plant, whilst the coalite, which has been obtained by distillation of the fuel, gets on the chain grate in a very hot state, and is there completely burned.

In the tar-separator plant, as shown in Fig. 2 and 3, the mixture of water vapours, tar vapours and gases is first cooled in the cooler *l*), to the temperature required for the tar separation, then reaches the gas exhauster *k*) and finally the tar separator *i*). The tar is separated partly in the cooler and partly in the exhauster, and the last rests are eliminated in the tar separator, specially designed for this kind of gas and low-temperature-tar on the lines of the Pelouze principle.

The exhauster produces the necessary suction and pressure to suck the gas from the combustion chamber through the distillation shafts, pipes and cooler and to press the cleaned gas through the tar separator-pipes *e*) to the burners *f*), where it is finally burnt.

The tar separated in the blower and separator is carried to the lower part of the cooler, and is thence discharged to the tar reservoir, from which it is pumped into the tank trucks.

The arrangement, as described for the Lichtenberg plant, is practically the same as for all plants.

This kind of plant can be used only for non-caking coal in pieces between about 5/8″ and 6″. Coal-dust and caking coal is not fit, as it does not allow the heating gas to penetrate the fuel equally. In Lichtenberg mostly lignite briquettes were burnt.

Several plants in Upper Silesia (Prinzengrube and Transchold Segengrube) use a very bad pit coal with high contents of ashes (up to 40%).

A Norwegian plant is built at Christiania for the use of a very bituminous cannel-coal from Spitzbergen.

Another plant in Brazil is designed for the combustion of Brazilian lignite.

Several plants are being erected at the power station of the German government Railways for firing of lignite briquettes.

A thorough investigation has been made on the Lichtenberg plant, the chief data of which will be given afterwards.

The temperature in the lower part of the distillation shaft averaged 500–700°C., and showed a linear reduction upwards. Thus the distillation of the fuel proceeds at low temperature, and the tar produced showed all the characteristic properties of low-temperature-tar, i.e. lack of naphthaline and benzoles on the one hand, presence of paraffin and benzines on the other hand. The heating value of the gas and the yield of low-temperature-tar increased with the quantity of the gas sucked through the distillation shafts.

The capacity of the exhauster of Lichtenburg plant proved not to be sufficient; thus the yield of tar amounted to about 5.5% of the coal weight; with a more efficient exhauster the yield of tar could have been considerably increased.

The heating value of the gas reached 165 B.T.U.

Comparative trial runs of the boiler with and without operation of the distillation arrangement showed the following interesting features:

With operation of the distillation arrangement it was easily possible to get a higher contents of CO_2 (14%) in the combustion gases than without it.

The reason is that the fuel gets on the grate in a very hot already burning state, so that all the air penetrating the grate must come in contact with glowing coal and cannot come unburnt in the flues. Another reason is, that by the additional combustion of gas, it is easily possible to reduce the secondary air to the lowest necessary degree.

The higher contents of CO_2 in the flue gases gives, of course, smaller losses of sensible heat, and in Lichtenberg it was a fact, that with a yield of 3% of low-temperature-tar no additional consumption of coal was necessary to raise the same quantity of steam, as this is the case without tar recovery.

The efficiency of the boiler, respectively the boiler and distillation plant was at normal load without operation of the distillation plant 76–77%, and with operation of the distillstion plant 79–82.5%.

Even better results were obtained in the Pringengrube plant in upper Silesia.

Here on the coal mine generally a coal with 4,600 calories per kg. and 30–40% of ashes is used in the own power station, as this poor fuel cannot be disposed off for sale.

The efficiency of the boilers burning this fuel used to be about 45–50%, as no higher contents of CO_2 in the flue gases than 6–8% could be attained. Now the boilers, which got the distillation arrangement reach an efficiency of about 76% i.e. an improvement of about 24 to 31%.

The reason has again to be found in the facts, that 1) the coal reaches the grate in a burning state, and good fire can be kept all over the grate and 2) that the secondary air supply for the gas burners can be limited regulated to the smallest necessary degree.

Therefore with operation of the distillation plant and at even a very great tar recovery the consumption of coal for generating the same quantity of steam did not increase, but was in fact smaller, because it was possible to improve at the same time the efficiency of the boiler to a very considerable amount.

In "Pringengrube" the yield of low-temperature-tar amounts to about 7.5%.

These two examples show, that the question, which very often arises, if the consumption of coal will increase, if low-temperature-tar recovery is used, can not be answered quite generally. It depends on the boiles and coal used before. Of course, the tar recovered is not used for generating steam, and so one would expect the consuption of coal to increase in the same degree, as tar is recovered. But experience has shown that together with tar recovery generally a considerable improvement of the efficiency takes place. It depends on the degree of this improvement on the one side, and on the quantity of tar recovered on the other side, if the consumption of coal will decrease or increase.

Generally spoken one can say, if the efficiency of the boiler plant before instalment of the tar recovery plant used to be very high (about 80%), the tar recovery will raise the coal consumption for producing the same quantity of steam. If the boiler efficiency was bad before instalment of the tar recovery plant, the coal consumption may be the same and even smaller with tar recovery.

The main advantages of this kind of plant as compared with other low-temperature-tar recovery plants are the following.

1) Based on the quantity of tar recovered the cost of the first instalment are only one fraction of the cost of any other low-temperature-tar recovery plant. For instance, the whole arrangement, including erection, for a boiler of 500 sq. meters heating surface, which may yield about 5–7 ton low-temperature-tar per day, will cost about ¥60,000—.

2) This tar recovery plant does not want special attendance, but is kept working by the stokers already employed. All apparatus are of simple design. Thus the whole maintenance costs are smaller than can be attained by any other plant.

3) Compared with the process of gasifying the coal in producers with low-temperature-tar recovery, and using the gas for power generating in boilers, boiler furnaces with low-temperature-tar recovery give a much better efficiency (about 80%) than the first-named process (about 65%).

Rentability of a boiler furnace with low-temperature-tar recovery adapted to a boiler of 500 sq. meters heating surface.

To give an idea of the rentability of such a plant, the following calculation may be made. Supposing:—

Heating surface of the existing boiler ....500 sq. m.=4,650 sq. ft,

Fuel ....Pit-coal.

Heating value of the fuel . . 5,600,000 cal. per ton.
Capacity of the boiler . . . . 70 ton coal per day.
Boiler in operation . . . . . . 250 days per year.
Yield of low-temperature-tar . . . . 8% of coal weight.
Heating value of the tar . . 9,000,000 cal. per ton.

Supposing the efficiency of the furnace be improved by the new arrangement by 10%, i.e. per 1 ton of coal are saved 5,600,000 × 0.10 = 560,000 cal; by obtaining 8% of low-temperature-tar, there are 0.08 × 9,000,000 = 720,000 cal. per 1 ton of coal, which will not be used for producing steam. Thus 720,000 − 560,000 = 160,000 cal. per 1 ton of coal or about 3% of coal are to be burnt additionally according to the low-temperature-tar recovery.

Power required by the exhauster . . . . 15 K. W.
Cooling water required by the cooler 160 cbm. per 24 hours = 5,664 cub. feet per 24 hours.
First cost of the boiler furnace with low-temperature-tar recovery, including erection. . . . . ¥ 60,000.—
Cost of coal . . . . ¥ 15 per ton.
Cost of low-temperature-tar . . ¥ 35 per ton.
Cost of power. . . . . ¥ 0.02 per Kw-h.
Cost of cooling water . . . . . . ¥ 0.04 per cbm.
Depreciation and interest . . . . 15% of first costs.

Income per year by selling of tar :—
250 × 70 × 0.08 × 35 = ¥ 49,000 per year.
Expenses per year for Depreciation and interest :—
60,000 × 0.15 = ¥ 9,000 per year.
Additional consumption of coal :—
250 × 70 × 0.03 × 15 = ¥ 7,880 per year.
Cooling water :—
250 × 160 × 0.04 ¥ 1,600 per year.
Power :—
250 × 24 × 15 × 0.02 = ¥ 1,800 per year.
Total expenses per year for tar recovery
¥ 20,728 per year.

Thus, the net profit amounts to ¥ 28,720 per year. Or the first cost of the plant are gained already after 2 years of operation.

This calculation is based on average figures, it will change more or less with the plant concerned. But it will be easily possible to make up a new calculation of rentability by adapting the figures given above to the special case.

At any rate, the calculation shows that the boiler furnace with low-temperature-tar recovery gives a good rentability under Japanese conditions. Japan possesses a good deal of non-caking or only very slightly caking coal, which is well fitted for this plant. The natural resources of oil supply are rather limited as against the always increasing want for fuel and other industrial oils.

Thus it seems that the boiler furnace with low-temperature-tar recovery may become in future of considerable interest for Japan from an economical standpoint of view, as well as from a national one.

Makers of the above plant: The Julius Pintsch A.G., Berlin, Germany.

Sole agent for Japan: Otto Reimers & Co., Machinery Dep't. Hamburg-Tokyo-Osaka.