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Process for the carbonisation of shale in its own bed

Proposals have been made to carbonize coal seams underground without removal of the coal. But it was difficult to confine the carbonization to a limited area and to prevent explosions of the liberated gases.

According to this invention it is proposed to carbonize the oil shale in its own stratum. It was found that the underground carbonisation of oil shale can be easily performed if we utilise old workings (goafs) laid out in the lower levels of the shale oil stratum as a carbonisation chamber. The roof of the chamber is loosened by explosives so that a carbonisation chamber is provided. It was very surprising to observe that the solid rocks which form the walls of such a chamber are not carbonised after the loosened shale has been kindled.

According to the invention the shale is removed from between two galleries which have been dug into the shale deposit. The workings are separated from each other and from the galleries by walls of solid rock. Approximately one-fourth of the shale rock is removed and carbonized in an above-ground furnace. The shale which has been left in the deposit is loosened and carbonized by an underground carbonization method. Since the carbonised shale has almost the same volume as the raw material the formation of depressions is prevented.

It is preferable to arrange the underground chambers and to carbonise the shale according to the direction of the maximum slope of the strata in order to prevent that the carbonisation water and the condensed oil and the condensed oil flow back to the carbonisation and combustion zone.

The attached sketches #1-5 represent the preparation and the working of the oil-shale deposit.

(The sketches are missing; so that no explanations of the sketches can be given).

The shale is kindled at one end of the chamber and air is sucked into the chamber which by burning the fixed carbon of the shale produces hot flue gases which preheat and carbonise the shale. The velocity of the proceeding carbonisation zone is approximately 4-5 m. per day. The liberated gases and vapors are led to a condensing system which is arranged above ground.

It is possible to recycle lean gases or flue gases in order to control the velocity of the proceeding carbonisation zone.

(This is a copy of the survey given in frames 20001-2; the following more exhaustive text is taken from the original and constitutes a literal translation. M.B.)

Two vertical shafts (1) and (2) are driven into the workings in the strike of the stratum. The parallel horizontal drifts (3) and (4) are driven in the inclination of the seam. At each of the shafts (1) and (2) a safety pillar is left standing. Thereafter, the shale between the two horizontal drifts (3) and (4) is worked heading upwards using movable props (7) of about 2 m. thickness, and the roofs of the rooms are "pressed" (gedrückt), that is, they are brought down. The individual rooms are 1.5-3 m. wide. After moving forward the hauling medium (chute, conveyor belt or track-way) and withdrawing the movable props and replacing them in the new room, the roof of the old panel is brought down; if necessary, shot down. The farther the drifts advance, the higher the level at which the roof layers will break and fall, until the entire excavated area is filled up by the subsiding material. Since the roof subsides in more or less sizeable pieces, cavities evolve in the heaped material sufficient to permit, later on, the carbonization gases to pass. It is an advantage for the carbonization process to have the horizontal (3) and (4) drifts uniformly filled up, too, so that there are no air channels left which might hamper the uniform advance of the carbonization zone. For this reason it is suitable to work retreating (Rückbau) and to blast the roofs of these galleries, too. We have found out experimentally that in Württemberg oil-shale mines, for instance, the roof over the old workings will automatically subside in about four times the thickness of the material excavated. In this way, the entire remainder of the oil-shale layer - - they are 8-12 m. thick - - is loosened and subsides, thus forming the carbonisation charge stock, whilst the plastic Jurassic marls and the opal-clay of the roof settle upon the subsided oil shale, sealing it hermetically towards the upper ground (Fig. 2). When we reach safety pillar 6 of the second gallery, props are made of old mine timber as a substitute for the movable props leaving, as a precautionary measure, a gangway open along the safety pillar.

.... Confer fig. 3 (not on the reel. M.B.).

The entrances to the carbonisation room 9 from the lower drift (1) are closed off air-tight by means of fireproof partition walls (10), (11) and (12). One or several of the gas-discharge pipe-lines (13) run through the isolating walls into the carbonisation chamber. Another pipeline serves for draining the carbonisation water. It is suitable to place the carbonisation pipes at the foot wall whilst the gas pipelines are arranged above it. Suitable inlets for the combustion air may be provided in the connecting galleries between the carbonisation room and the upper shafts (2). The injected combustion air must be either enriched with oxygen or with exist gases (nitrogen and carbon dioxide) so that the velocity of distillation may either be accelerated or retarded. Therefore, it is necessary to provide a device for adjusting the quantity of combustion air to be introduced or for throttling it, so that any desirable gas pressure may be obtained in the carbonisation chamber. It is advisable to maintain a pressure slightly below atmospheric pressure in sucking off the distillation gases in order to be sure that none of the distillation gases come into galleries 1 and 2 and thus into the other workings which are worked at the same time.

The oil shale is kindled from the gangway by pouring combustible fluids (oil, tar) over the timber props left at that place, and lighting them. By sucking off the combustion gases at the lower end of the carbonisation chamber gases at the lower end of the carbonization chamber by means of a suction pump - - it is suitable to install it above ground - - and, if necessary, by reducing the quantity of combustion air, which is introduced from the upper gallery (2), or by admixing oxygen or exit gases, any suitable gas pressure and any suitable distillation velocity can be provided for in the carbonization chamber.

The carbonisation rooms where preparatory work takes place can be protected against the penetration of distillation gases from the carbonisation chambers in operation by having the ventilator can blow air into the workings. In this manner a gauge pressure of a few mm. water column is generated in the workings, neutralising any fluctuations of the gas pressure occurring in the carbonization chambers.

The size of the individual carbonisation chamber depends upon the amount of oil shale to be carbonised each day. If the carbonisation chamber is 20 m. wide, the total depth of the bed being 8 m. - - of which a portion corresponding to a depth of 2 m. has been previously mined — the length of the carbonisation chamber being 100 m., the volume of shale in it is 120,000 m³. If the carbonization zone is advancing about 4-6 m./day from gallery 2 to gallery 1, that is, in the direction of the incline of the bed, 600 m³ oil shale are carbonised every day. By enlarging the individual carbonisation chamber or by operating several carbonization chambers at the same time, pursuant to the method of this invention, several thousands of tons of shale can be processed per day.

In opening out a mine, we have assumed that the bed can be opened by tunnels from the bottom of the valley, like the Württemberg oil-shale beds.

We have already stated that the carbonisation zone will average an advance of 4-6 m. per day. In getting ready workings 20-30 m. wide, the working front will progress about 1-1/2 m. per day. Therefore, in one carbonisation unit, at least three workings must be worked at the same time so that when one room has been completely carbonised the carbonization of the next room can start without interruption. That is why we have always combined three headings, a, b and c (Fig. 8) into the carbonisation groups A, B and C.

Moreover, we must protect the miners working in the drifts or headings against explosions of the carbonisation gas and against the possibility of firedamp pressing the hot gases out of the carbonization chamber. For this reason, the carbonisation units are completely separated from the working units. Again, it is suitable to provide in each of them three units, in one of which the three carbonisation stalls are being carbonised one after the other, while another one is mined, and the third one is opened out. In order to have, at all times, a reserve available along with the carbonisation - opening up - and mining units, also one finished mined group has been provided for. When the carbonization of one group is entirely completed carbonisation is started in the group which had been held in reserve. The mined group must be ready at that time. Now it becomes the reserve group and the opened up group is now being mined. Care must be taken that no miners are working in the carbonization unit. If necessary, additional opening-up groups must be provided for.

The by-products contained in the carbonisation gases are recovered in the familiar manner in the above-ground condensers. There is no premature condensing of valuable oils in the carbonisation chamber , since the gases are rarefied to such an extent, the partial pressure of the oils thus being so low that oil will not separate out at the temperature prevailing in the workings.

If the combustion air is introduced into the carbonisation chambers by special above-ground pipelines, we may add a portion of the distillation gases to the combustion air after separating out their by-products; we may also recirculate them in the carbonisation chamber and burn there the carbonisation exit gases, thus creating a kind of recycle carbonisation with recirculated purge gases, thus lowering the partial pressures of the by-products still more and preventing them from condensing at too early a stage.

Patent Claims

1) A method of carbonising oil shale in underground workings, distinguished by the feature that panels are used as carbonisation chambers. The carbonisation chambers are filled by bringing down the roof layers of the oil-shale bed.

2) Method pursuant to (1) distinguished by the feature that the carbonisation takes place at atmospheric pressure or at a somewhat lower pressure, generated by throttling the amount injected of combustion air or combustion gases.

3) Method pursuant to (2) distinguished by the feature that the air conditioning of the carbonisation rooms in preparation provides for more than atmospheric pressure while the pressure in chambers where the carbonisation is actually taking place is less than atmospheric pressure.

4) Method, pursuant to (2) and (3) distinguished by the feature that the combustion air (with or without an admixture of oxygen or waste gases) is introduced through special above-ground pipelines.

5) Method, pursuant to (1) to (4) distinguished by the feature that the carbonization chambers are arranged in retrograde workings (Rückbau) between two parallel vertical galleries.

6) Method, pursuant to (1) to (5) distinguished by the feature that carbonisation chambers and working and opening-up chambers are extensively separated from one another.

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