Peat Extraction from Lake Sediments in the Northern Districts, the Sakha (Yakutia) Republic

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Abstract. The article The article examines the possibility of extracting sod fuel peat to replace imported coal. A possible raw material base is considered for producing molded solid peat-based fuel in permafrost conditions. The production of molded peat products in the form of sod peat is proposed as an option. The experimental work on drying sod peat shows that peat can be extracted and dried to standard moisture content in the conditions of northern Yakutia. A flowsheet of producing sod peat from lake peat by hydraulicking is presented. According to the flowsheet the peat mass is loosened, liquefied by lake water, sucked in by a dredger pump and pumped through a pulp pipeline to the shore, where it is dewatered in geotubes to the molding water content. After dewatering, the geotubes are cut and the peat mass is loaded into a peat spreader mixing the peat, forming it into cylindrical pieces, and spreading it on a drying field. When molded, the peat structure is modified chemically to obtain strong and durable products. Having reached sufficient strength, peat sods are piled in a stack supplied with a trench for artificial ventilation at its base. The peat is dried to a final moisture content of 24–30%.

1 Introduction

Verkhoyansky and other uluses (settlements) of northern-eastern Yakutia can live only under the conditions of the so-called "northern delivery" when energy resources, foodstuff and goods are brought in by water transport in summer and road transport in winter. Currently, the energy sector of the area is completely dependent on delivered coal and diesel fuel. The area has no coal, gas, or oil, but plentiful peat deposits.

The Government of the Sakha (Yakutia) Republic has proposed to use peat fuel for Verkhoyansky boiler houses. Peat fuel, according to preliminary calculations, should be about half the price of the delivered coal. The Government has set the task to assess the peat deposits in the Verkhoyansky district for the possibility of extracting and using peat in boiler houses for heat supply [1-3].

In 2012, the Department of Geotechnology and Peat Production conducted an additional survey of two fields.

The Khotogor field is divided into a near-lake frozen part and an underwater (lake) part. Most peat reserves are in the lake underwater part. The lake water depth varies from 1.5 to 1.8 m. The lake concentrates the major part of peat reserves, with its layer thickness being 1.6–5.65 m.

The Yylakh deposit is also divided into a near-lake frozen part and a lake underwater part. Both parts account for equal parts of peat reserves. The lake has an unfrozen peat layer with an average thickness of about 2 m. The lake water depth varies from 1.0 to 1.5 m. The maximum lake depth including peat deposits is 5.1 m at a single point. The peat deposit has continuous boundaries and its peat layer is almost flat throughout the deposit.

The total area of the useful fuel deposit is 961 ha and the total useful fuel reserve for both fields is over 18 million m^3 (about 2 million tons). The total reserve of these two fields is more than 60% of the total reserve of the entire industrial Tabalakh group. According to the degree of decomposition (45–55%) the Yylakh and Hotogor fields are good fuel deposits.

2 Results

For the production of small-scale peat, a field located under Lake Khotogor was considered which does not freeze in winter and has reserves of about 800 thousand tons of air-dry peat. It was considered advisable to extract peat from the bottom of the lake, where the thickness of the peat layer can reach up to 5 m. This peat does not freeze under the water layer in frosts of 50... 60 degrees, characteristic of this region, so peat extraction does not depend on the degree of thawing of the deposit.

A pontoon excavator with a land pump was proposed as a mining machine. The removed pulp is transported ashore through the pulp line, dehydrated to moulding humidity in geotubes and lined on the drying field with the help of a styling machine.

In the process of styling, peat is chemically modified in order to obtain a durable product. After drying to humidity 57... 60% in the field with the implementation of technological operations to intensify drying, pieces of peat are removed to the stack (under the canopy), where they are dried to humidity 30% and below using artificial ventilation (if necessary with sublimation) [4-6].

3 Discussion

Experimental work carried out in the Nenets National District and Kamchatka has shown that peat extraction is possible even under these conditions if the climate issues are taken into account and adapted to.

Molded sod peat from reserves located in the bottom layer of Lake Hotogor can be produced with a technology similar to that of sapropel extraction consisting of hydraulicking peat pulp with a dredger and its thickening. Then peat mass with a moisture content of 80–82% is transported to the place of molding and spreading where it is formed and spread out for drying with a towered spreader. A pontoon single-bucket excavator with a dredger pump as a replacement working body (Fig. 1) is proposed to be used as a dredger. This option allows the excavator to be used not only for peat extraction during the season but also for other work during the rest of the time.

Fig.1. Swampking Pontoon Excavator with Powerful Dredger PD 3000.

For the thickening of peat pulp, the most economical scheme is the scheme using containers (geotub) sewn from woven material - geotextile (Fig. 2) Geotubes are located on a special site near the reservoir and are connected to the dredged pulp pipe. Dehydration of the pulp is carried out to humidity 80... 85% for about 20 days, whereupon the geotubes are cut and the finished mass is loaded by a frontal loader into vehicles and delivered to the styling site. The brought mass is loaded by the frontal loader or single-bucket excavator into styling machines of type ASK-1 (or an analogue of the Irish production DIFCO) and lined on the drying field.

Fig. 2. Geotube in working condition.

For lake peat, two dewatering cycles at one site will be sufficient for a given peat production volume of 10 thousand tons. Calculations showed that with single-layer laying, the geotube has a sufficient area of 5 hectares. Geotextile, after using it for dewatering, can be used in road construction as a substrate for the roadway.

Preliminary experiments on the formation and drying of suspect peat showed that this low-lying peat of a high degree of decomposition is prone to crack formation (Fig. 3). Therefore, to obtain durable products, it is necessary to take measures to mitigate the drying regime or to carry out chemical modification of peat. The modifier introduced into the peat, affecting the structure formation process and mass transfer in the peat system, makes it less prone to crack formation [7-8].

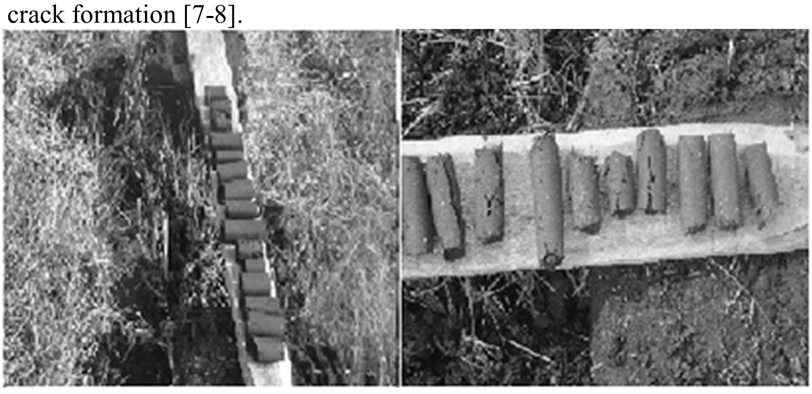

Fig. 3. Molded peat pieces: on the left - immediately after molding; on the right - after 20 hours of drying under conditions of polar day.

The treating peats with chemical additives are used two methods: volumetric and surface. In the first case, the additive is introduced into the initial peat mass in the form of an aqueous solution of various concentrations and is thoroughly mixed in the processing device of the styling machine. In the second case, the aqueous solution of the preparation is injected under pressure into the annular cutout inside the forming cylinder (mouthpiece) and wets the surface of the sod peat. The styling machine is equipped with a solution tank and a pump for its supply.

It is proposed to use volumetric treatment, which allows strengthening intermolecular and inter-aggregate interaction in peat and making the structure of sod peat after drying more durable. Surface treatment reduces the drying intensity, while reducing moisture content gradients along the section of the sod peat and reducing shrinkage stresses, therefore, the number of cracks is significantly reduced in the finished product. But reducing drying intensity increases cycle time. which in our circumstances is undesirable.

The volumetric treatment is most often used cationic preparations of both organic and inorganic nature. The use of chemicals optimally selected for a particular peat allows us to 1.5... 2 times increase the strength of the sod peat and 35... 45% reduce their water-absorbing ability (Fig. 4) [9-10].

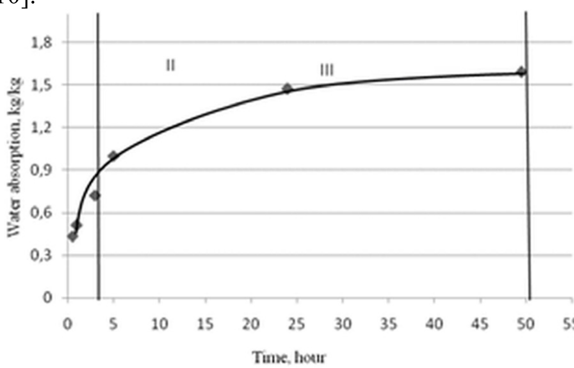

Fig.4. Kinetic curve of water absorption by sample of hydrophobically modified sod peat.

Back in the 60...70s of the last century, the effectiveness and feasibility of drying sod peat in stacks was shown and were proposed well-founded technologies for drying sod peat. This ensured more complete use of weather conditions and increased the reliability and efficiency of peat production. The use of drying operations of molded sod peat with the help of natural and forced ventilation of stacks increases seasonal collections by an average of 1.5 times due to reduced drying periods and increased number of cycles (Fig. 5). The energy consumption per day is approximately 2 kVtch/m^3. By increasing seasonal collections and the associated reduction in production areas, an economic effect can be obtained by reducing the cost of the finished product.

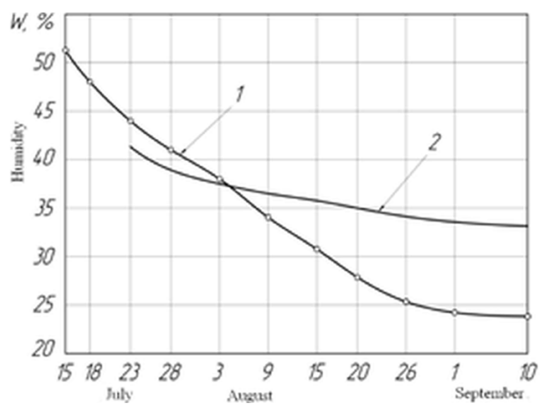

Fig. 5. Reduction of humidity in stack sod peat: 1 - with active ventilation; 2 - with natural ventilation.

Sod peat, removed at high humidity 57...60%, is poured into the place of storage, where a sub-stacked air duct is pre-equipped and connected by a transition pipe to the fan. The air duct is a perforated metal pipe with a diameter of 0.5...0.7 m with a plug at the end. Fan, air duct and stack are exhausting ventilation system (Fig. 6). When the fan is turned on, a underpressure is created in the ventilation channel and air moves from the stack surface to the channel.

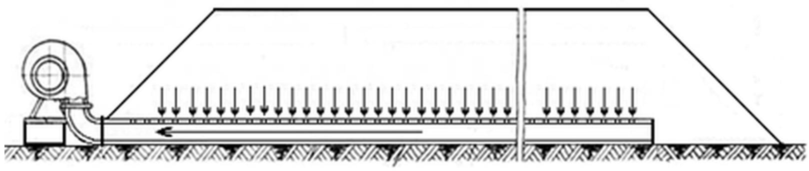

Fig. 6. Diagram a ventilation system of the stack.

As a result of the contact of air with the heated surface layers of the stack, its temperature rises by 1...4 degrees, as a result of which the water-absorbing ability increases by 1.05...1.3 times. This ultimately leads the intensity of air absorption of moisture from peat increases and, therefore, the intensity of peat drying.

Active ventilation of the stack is performed in case of deterioration of weather conditions. For this, a mobile ventilation plant is used with an impeller with a diameter of about 0.7 m. This mobile ventilation plant is installed on a tractor. Ventilation mode: first, suction of air for 10... 15 minutes, and then pause 45... 50 minutes. In this mode, one ventilation plant can serve several stacks. Usually periods are used dry idle days. Ventilation is carried out in August - early September daily for 20... 25 days. The total duration of ventilation is 3... 4 hour per day.

4 Conclusion

Underwater peat extraction with a dredger pump can be considered the most effective method among other ones, for example, draining a reservoir and digging peat. When hydraulicking is used, a reservoir is preserved and its bottom is cleared of organic and organomineral sediments. The peat pulp extracted from the lake bottom is pumped by a dredger pump through a pulp pipeline to the shore, where it is dewatered in geotubes to a moulding water content of 80–85%. When dewatered, the peat mass is loaded into a towered spreader which mixes the peat simultaneously treating it with chemical additives, forms cylindrical sods and lines or scatters them on the allocated sites sufficient in area and relatively flat, without shrub vegetation. When dried, the sods are agitated once and when the sods reach their water content of 57–60%, they are picked up and stacked on specially prepared sites. The sites are equipped with a perforated pipe having a delivery pipe. When the stack grows, the perforated pipe turns out to be in its sole along the central longitudinal axis. When the stack formation begins and the following cycles are harvested, the sods are further dried in a soft mode due to natural ventilation. At the end of the season, forced ventilation is used and the water content of the finished product reaches 25–30%.

Using peat chemical modification and changing drying modes will ensure high-quality peat fuel to be extracted from underwater lowland crumbling peat of a high degree of decomposition [11].

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