Vortex-oscillatory pump for the extraction of sapropel
The existing types of chemical fertilizers have very serious lacks:
- harmful effects on human body and animals;
- require a fixed dosage;
- expensive.

Use of sapropel as fertilizer can solve all problems.
Sapropel – valuable fertilizer

Sapropel - is freshwater bodies sediment consisting of organic substances and mineral admixtures of the age of a few tens or even hundreds of thousands of years.

Eco-friendly organic fertilizer for seedlings, indoor and balcony flowers, vegetable gardens, farms, feed additives, building materials, green feed and bait make from the sapropel.
Production of sapropel today

The plant for the extraction of sapropel includes:
- The pump for pumping of sapropel;
- A device to liquefy the sapropel in front of suction pipe of the pump;
- A pipe for pumping of sapropel from the pump to shore;
- A floating device on which the pump is installed;
- Drying of sapropel;
- Granulation of sapropel;
- Packing of sapropel;
- diesel power station to provide electricity to all units of the plant.
The variety of composition and properties of sapropel, significant geological resources, a wide range of uses, the prevalence and availability of the extraction - make sapropel as valuable minerals.

Now the various methods and equipment for extraction of sapropel and technology of its processing are developed and used.

However, existing methods and equipment for extraction of sapropel have significant lacks. As a result, quality and product properties of sapropel are reduced and continuity of the process of extraction and processing of sapropel is broken, the energy consumption for drying of sapropel are increased. And they are very expensive and not affordable especially for small farmers.
Data analysis

We have gathered a database of pumps for the extraction of sapropel and their characteristics are listed below.

The absolute indices of power, productivity and price of various equipment for extraction of sapropel are used as the main characteristics.

There are also presented the relative magnitudes:
- specific cost of equipment (the ratio of price to the performance of equipment);
- specific power of equipment (the ratio of power to the performance of equipment);
- cost index of 1 kW of equipment power (the ratio of price to the power of equipment).

Unfortunately, many companies give incomplete information about their equipment, so the histogram shows only those equipment, which had all the necessary characteristics.
Power of equipment for the extraction of sapropel

Manufacturers of equipment for the extraction of sapropel
Productivity of the equipment for the extraction of sapropel

Manufacturers of equipment for the extraction of sapropel

- Minimal productivity of the equipment, m³/h
- Maximal productivity of the equipment, m³/h
The price of equipment for the extraction of sapropel

Manufacturers of equipment for the extraction of sapropel

- Vers. Dredge-SR12 LP (NMS)
- Bravo 800 (Grindex AB)
- Bravo 700 (Grindex AB)
- Bravo 500 (Grindex AB)
- Bravo 400 (Grindex AB)
- Bravo 300 (Grindex AB)
- Bravo 200 (Grindex AB)
Specific cost of equipment for the extraction of sapropel

Manufacturers of equipment for the extraction of sapropel

- Specific cost, $S_{\text{max}} = C / U_{\text{max}}$, thousand rubles / (m³/h)
Specific power of equipment for the extraction of sapropel

Manufacturers of equipment for the extraction of sapropel
The cost of 1 kW of power of equipment for the extraction of sapropel

Manufacturers of equipment for the extraction of sapropel

The cost of 1 kW of power, thousand rubles / kW
By analyzing and comparing the data which we collected in the database and presented in the histograms, we can conclude that all the existing types of dredgers and pumps for the extraction of sapropel have serious lacks:

- low productivity;
- high cost;
- very low efficiency;
- complexity of the installations;
- short service life.

However, this equipment is used, because there is no better.
Work on the pumping out of sapropel and the dredging of water bodies is quite complex and problematic task.

We offer our technology of pumping out of the ground and sapropel. Our technology consists in the application of very intensive vortex motion which was received by mechanical vibrations (without rotation of the blades, wheels, cylinders and other bodies, without a compressor, etc.).

(KNOW HOW Sorokodum E.D.)
The following shows a general view of fluid motion in our vortex.

Picture 2. The trajectory of the fluid particles (or solid particles) in the vortex.

Left picture: particles inside the vortex rotate and simultaneously move upward, and then, by rotating, move down on the outside of vortex. Inside the vortex - emptiness.

Right picture: shows the trajectory of a particle in a vortex in more detail - except the vortex motion, the particle has also an oscillatory motion.
Working principle

The pump is a conventional tube, which is positioned close to the surface of the sapropel, which should be dilute and repumped (see fig. 2).

Fig. 2. Pipe-Pump
From Fig. 3 that very intensive vortical cloud with the presence of a high concentration of cavitation bubbles of air is formed under the tube. This vortex-cavitation cloud able to easily loosening the top layer of sapropel and then dilute it. We were doing experiments with diluting of water-sand mixture and water-land mixture. Positive results were obtained.
Then the liquefied sapropel rises up inside the vibrating tube. See Fig. 4. At the same time, due to the intense vortex motion and vibration inside the pipe, sapropel rises up and thus continues its liquefaction.

The Liquefaction sapropel rotates with high speed. Due to this large centrifugal acceleration appear and the fluid is pumped to tube further (similar to a centrifugal pump).
General view of the pump to liquefy and pumping out of sapropel illustrated on Fig. 5 and 6.
Comparison of our proposed vortex-oscillatory pump with analogues

<table>
<thead>
<tr>
<th>Type of operation</th>
<th>Analogues</th>
<th>Vortex-oscillatory pump, proposed by us</th>
</tr>
</thead>
</table>
| Loosening of sapropel     | Additional devices (such as rotating mills, etc.), which are submerged under the water up to surface of sapropel | • There are no additional devices.  
• loosening occurs with help of vortex-cavitation cloud, which coming out from the tube below |
| Liquefaction of sapropel  | Occurs almost weakly                                                      | Very intensively with help of vortex-cavitation cloud, which coming out from the tube below                |
| Suction of sapropel       | With the help of different types of special devices, which are rotate inside the pipe. This system can become clogged, wear out and break down. | • There are no any device inside the pipe.  
• Suction of sapropel occur with help of a vortex in a pipe.  
• There are no rotating or fixed parts inside the machine.  
• The reactor (tube) does not rotate. |
| A further liquefaction of sapropel | occurs almost weakly                                                      | Very intensively with help of a vortical and vibration impact on sapropel inside the pipe. |

Table 1
Continuation of Table 1

<table>
<thead>
<tr>
<th>The depth of extraction of sapropel</th>
<th>For the extraction of sapropel are used screw pumps. However, they allow you to get low pressure. And therefore production is carried out at shallow depths - up to 20 meters.</th>
<th>The liquid rotating in the pipe pump may have a very high centrifugal acceleration that can not be obtained in conventional centrifugal pumps. Especially on screw pumps. This provides a high pressure for pumping the fluid. Accordingly, the depth of mining sapropel can be anything.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific power of equipment kW/(m3/h)</td>
<td>0,05 - 2</td>
<td>In the zone of pumping and inside the pump intensive vortex, vibration and cavitation effects act on particles of medium, which leads to liquefaction and reducing the viscosity of pumped medium. Accordingly, the required capacity of pump is reduced.</td>
</tr>
<tr>
<td>Specific cost of equipment thousand rubles /(m3/h)</td>
<td>1,43 - 138,5</td>
<td></td>
</tr>
<tr>
<td>Equipment reliability</td>
<td></td>
<td>There are no rotating or fixed parts inside the pump and under the water. Pump-pipe does not rotate.</td>
</tr>
</tbody>
</table>
The conclusions

1. The cost of pumps, which we propose to work out, is lower than cost of analogs.

2. High productivity.

3. Lower energy costs for extraction of sapropel.

4. Compact and small weight.

5. The pumps can have a conventional, high or low pressure.

6. Ease of maintenance.
Financial Plan of development and serial production of vortex-oscillatory pump for extraction of sapropel

Table 2

<table>
<thead>
<tr>
<th>Name of the stage</th>
<th>Duration of the stage, months</th>
<th>Unit cost, million dollars</th>
<th>Quantity, pcs</th>
<th>Expenses, million dollars</th>
<th>Selling price per unit, million dollars</th>
<th>Revenues from sales, million dollars</th>
<th>Profit, million dollars</th>
<th>Net profit/loss, million dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D of pump for pumping oil sludge up to 100 m3/hour</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0.83</td>
<td>0</td>
<td>0</td>
<td>-0.83</td>
<td>-0.83</td>
</tr>
<tr>
<td>International marketing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>-0.1</td>
<td>-0.1</td>
</tr>
<tr>
<td>Payment of Know-How</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.33</td>
<td>0</td>
<td>0</td>
<td>-0.33</td>
<td>-0.33</td>
</tr>
<tr>
<td>Payment of patent</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.85</td>
<td>0</td>
<td>0</td>
<td>-0.85</td>
<td>-0.85</td>
</tr>
<tr>
<td>Production of the 1st batch of pump up to 100 m3/hour</td>
<td>3</td>
<td>0.0017</td>
<td>50</td>
<td>0.083</td>
<td>0.003</td>
<td>0.15</td>
<td>0.07</td>
<td>0.05</td>
</tr>
<tr>
<td>Production of the 2d batch of pump up to 100 m3/hour</td>
<td>3</td>
<td>0.0010</td>
<td>100</td>
<td>0.100</td>
<td>0.003</td>
<td>0.30</td>
<td>0.20</td>
<td>0.16</td>
</tr>
<tr>
<td>Serial production of pump up to 100 m3/hour, 1st year</td>
<td>12</td>
<td>0.001</td>
<td>5000</td>
<td>3.3</td>
<td>0.003</td>
<td>13.3</td>
<td>10.0</td>
<td>8.2</td>
</tr>
<tr>
<td>Serial production of pump up to 100 m3/hour, 2nd year</td>
<td>12</td>
<td>0.001</td>
<td>10000</td>
<td>6.7</td>
<td>0.003</td>
<td>26.7</td>
<td>20.0</td>
<td>16.4</td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
<td></td>
<td></td>
<td>12.3</td>
<td>40.5</td>
<td>28.2</td>
<td></td>
<td>22.7</td>
</tr>
</tbody>
</table>

Profitability (ratio of net profit to all expenses), % 185

The ratio of cost of R & D to the serial selling price of pump up to 100 m3/hour 312.5
The graph shows that investments in the pump up to 100 m³/hr starting to pay off in 15 months from the beginning of investment in research and development. Profit per 42 month is about 20 million dollars.
Substantiation of expediency of investment in the project

For comparison currently, the retail price of the pump up on productivity up to 100 m3/h is in ranges from 170 thousand rubles. Whereas the retail price of proposed by us vortex-oscillatory pump for the extraction of sapropel will be 60 thousand rubles.

Retail cost of our vortex-oscillatory pump for extraction of sapropel have is 3 times lower than retail cost of existing pumps for the extraction of sapropel. And our vortex-oscillatory pump has no lacks of traditional pumps.

Cost of the development of pumps on 100 m3 and will be 0.83 million dollars, and the profit after 4 years will total 28.2 million dollars.
"Vortex-oscillatory technology" Ltd. proposes to develop and manufacture the first prototype of vortex-oscillatory pump for extraction of sapropel.

Our available results of the theoretical and experimental studies will permit to develop vortex-oscillating pumps with the best technical and economic performance than the existing analogues have.

We can also develop and produce the first sample of vortex-oscillatory devices for dewatering and other technological operations required in the processing of sapropel.
We also can offer you to develop a full line of mining, pumping, dewatering, preparation, drying and packaging of sapropel and humus.

Figure 7. Complex of fertilizer production from sapropel

1 - of sapropel layer, 2 - Installation Sapropel, 3 - Warehouse-settler, 4 - Transportation of raw materials for recycling, 5-6 - preparation and mixing of sapropel components and components manufactured product, 7 - Granulation, 8 - drying of granules, 9 - sorting of granules, 10-11 - packing in different types of packaging.
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