Instructions for making biogas plant with a reactor volume of 5 cubic meters.

1. Select the installation, input and output parameters.

Main reference value for the design of a biogas plant with a given volume of the reactor is the proper value of the volume. It is known that the amount of substrate in the reactor in the form of a vertical cylinder should be about 80% of the total reactor volume. 20% are used to create a gas buffer. Consequently, the total amount of substrate in the biogas plant will be 5 * 80/100 = 4 m^3. The main types of raw materials for the installation with one reactor are various types of manure from domestic animals. This may be cattle manure, pig, horse, goat, sheep. According to statistics, these types of manure have the original 65% moisture content and density from 600 to 950 kg/m^3. Substrate in the biogas plant must have humidity in the range of 86-92%. To achieve the required moisture manure is diluted with water or urine, or have already taken in a dilute form of sewage system facilities for the animals. For maximum economy of materials in the production of a biogas plant and to maximize the productivity substrate is desirable to use a minimally acceptable moisture. Consistency of the substrate should allow for easy pour, pump and mix it. In appearance it resembles the consistency of liquid cream.

The density of dry matter of raw materials: $\rho_{dry}=(\rho_{raw}*(1-(h_{raw}/100)))/(1-\rho_{raw}*h_{raw}/100/\rho_{water})$, where

ρ_{raw} – density of raw materials, in this case 950 kg/m^3;

h_{raw} – moisture of raw materials, in this case 65%;

ρ_{water} – density of water, equals 1000 kg/m^3.

The density of the substrate: $\rho_{sub}=\rho_{dry}*(1+h_{sub}/(100-h_{sub}))/(1+h_{sub}*\rho_{dry}/(100-h_{sub})/\rho_{water})$, where

ρ_{dry} – density of dry matter of raw materials, calculated from the previous formula;

h_{sub} – required humidity of the substrate, in our case 86%;

ρ_{water} – density of water, equals 1000 kg/m^3.

If you calculate the density of the substrate with a humidity of 86%, it will amount to 979 kg/m^3. This value is of great importance for all further calculations.

The planned plant will operate in the mesophilic condition, although its design allows it to run in the thermophilic condition.

Amount of biogas allocated per day can be defined in two ways. The first way implies the presence of tabular data on the daily output of biogas from kilograms (tons) of dry matter of raw materials. The second method is based on information about the type of raw materials and reactor volume. Because accurate information about the performance of specific plants for specific materials can be obtained only by experimentation, it is possible to use for calculations a second indirect method. For example, the manure of cattle daily biogas output will amount to 1,1-1,3 reactor volume for pig manure - 1,3-1,5, for bird droppings - 2,5-3. Using pure bird droppings in one reactor scheme presents certain difficulties, so it is considered the first two cases. Thus, our installation in mesophilic regime could develop 5,5-7,5 m³ per day of biogas with a methane content of about 60%. As the calorific value, this corresponds to approximately 3,5-4,7 cubic meters of natural gas. It is clear that such quantities of biogas are suitable mainly for cooking and water heating. Heating of the reactor with burning own biogas in these volumes becomes uneconomical. Due to the almost global availability of electricity makes sense to apply a direct electrical heating of the substrate in the reactor by thermal electric heaters (heating elements).

For these commodities optimum fermentation cycle in the reactor is not more than 20 days. Biogas plant will operate in a continuous loop, i.e. every day it will be added to a portion of raw materials, and the same portion of sludge will merge. Thus, when the cycle in 20 days and the total amount of substrate in the reactor 4 cubic meters, the daily portion of the substrate up to 200 liters. Approximately the same amount of sludge will be removed every day.

The method of reverse recalculation determine that for the preparation of 200 l of substrate will need 78 kg of manure (82 liters or 8 buckets) and 117.5 kg (liters) of water. Thus, for the preparation of the daily portions of the substrate need 8 buckets of manure without the urine and 12 buckets of water.

In fact, to determine the moisture content of raw materials, especially in home conditions, impossible. But it is possible to determine the density. Density is determined by the method of Archimedes:

Take a bucket, measuring jug with the scale of the volume and balance. Pour into a bucket of 5 liters of water, measured a pitcher. Make a mark on the wall of the bucket. Pour out water. Weigh the empty bucket. Then, put in a bucket a number of raw material. Weigh the bucket. After subtracting the weight of an empty bucket you will have the mass of raw material m. Fill up a bucket of water up to 5 liters of a label in a bucket, measuring jug, how much water you added. When you add water mix the contents to leave the air

bubbles from the raw materials. Subtract the volume of 5 liters of water added. Get the volume V of raw materials. Divide the mass m in volume V, and get the density of the feedstock.

You can do without the humidity measurements. Enough to determine experimentally the necessary degree of dilution of raw materials with water. To do this, take the same bucket, scales and measuring jug. Place in the bucket a number of raw materials and determine its mass by weighing. Then gradually add water in small portions, and carefully stir the substrate, until it becomes fluid enough to flow freely through the pipes and mingle. Remember how much water you added at the same time. As a result, you get a mass and volume ratio of ingredients of the substrate. You can take it to them, rather than the previous calculated data.

The only quantity which still needs to calculate - is the density of the substrate. It is calculated based on the measured density of the feedstock. Knowing the density of the feedstock and water, as well as the proportion of the mixture, summarize masses and volumes of ingredients, and then divide the total mass of the total volume. The resulting density of the substrate, we will use in further calculations.

Manure must not contain fragments larger than 1 cm in length. Therefore, the presence of straw, it should be removed from the manure. You can also use the litter from a pre-chopped straw. Grinding a mixture of straw, with manure as energy-consuming that it loses the economic meaning of a biogas plant. The cycle of fermentation of straw up to 80 days, and the specific biogas output is about 1,5 times lower than that of cattle manure. So at 20-day cycle straw will come out of a biogas plant virtually no processed, and only in vain will hold a working volume of reactor.

For buffering and stabilizing the output pressure of biogas in the projected installation applies gas-holder - a pressure regulator with working volume of about 1 cubic meter. That's enough for buffering 3,2 hourly output of biogas. Will be applied dry-type gas-holder in the form of a bellows. Such a construction would operate the gas-holder in any climatic conditions, as well as reduce the required weight of the load gas-holder.

To supply a biogas plant will need a network of three-phase 380V and maximum current in each phase of up to 10 A. You can also use a network of single-phase AC voltage of 220V and maximum current of 20A or other networks with the equivalent peak power.

Power Automation biogas plant is made based on the digital timer and digital temperature control with sensor. This allows the flexibility to program the operating modes of installation.

Daily from the plant will blend in 200 liters of slurry. This sludge is a valuable bio-fertilizer. There should be capacity/location for discharge/storage of sludge. If you do not organize the sale of cuttings in greenhouses for growing potted plants, in the cold season the sludge will accumulate. For 4 months to accumulate 200 * 30 * 4 = 24000 liters or 24 cubic meters. You can dig a hole of the enough volume, reinforcing the wall boards. Part of the moisture will seep into the soil, but these sinks do not constitute harm, because they are decontaminated and recycled in a biogas plant. But the liquid fraction of sludge is also a valuable bio-fertilizer, so if its loss is unacceptable, then it makes sense concreted pit for biofertilizers and close the top to reduce nitrogen losses from the storage. It should be noted that the loss of nitrogen in the custody of the biofertilizers significantly lower than the same loss in unprocessed manure, because of bio-fertilizer nitrogen half is in the form of mineralized.