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THERMAL TREATMENT OF CLEARING SLUDGE IN MICROWAVE FIELD

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ABSTRACT
This paper approaches a few aspects regarding the possibilities of clearing sludge dewatering and drying in microwaves field. From a technical and economical point of view the microwave technique represents one of the most interesting heating methods.

1. FOREWORD:

Clearing sludge is the inevitable waste result of sewage treatment. Its quantity, composition and properties depend on the conditioned water, the chosen water purifying method and the initial purpose of the sewage purification.
As the quantities of such sludge are continuously growing it is extremely necessary to significantly diminish their volume by reducing their water contents. Such a drying degree (a minimum of 90% SS) is obtained by sludge treatment as to the flow chart shown in Figure 1. By such a treatment, besides the minimization of the remaining sludge volume, it also undergoes a purification process and it may lead to the reduction of noxious substances as a result of organic compounds oriented destruction and heavy metals immobilization.

Drying represents the process during which the inner water vaporization and adsorption are achieved, in connection with the sludge particles (~30 %) which cannot be achieved by mechanical dewatering. All the heat necessary for the endothermic reaction must be brought into this process from the outside. The heat transfer over the sludge can be achieved by means of:

- convection – when the heat is transferred by direct contact from the heating medium to the sludge to be dried;
- contact, when the heating medium (steam, thermal oil, hot water) does not come into contact with the sludge, but it is directed through a close system.
- molecular friction, due to extremely fast alignment and realignment of dipole molecules caused by the action of microwaves energy, directly transmitted to the material.

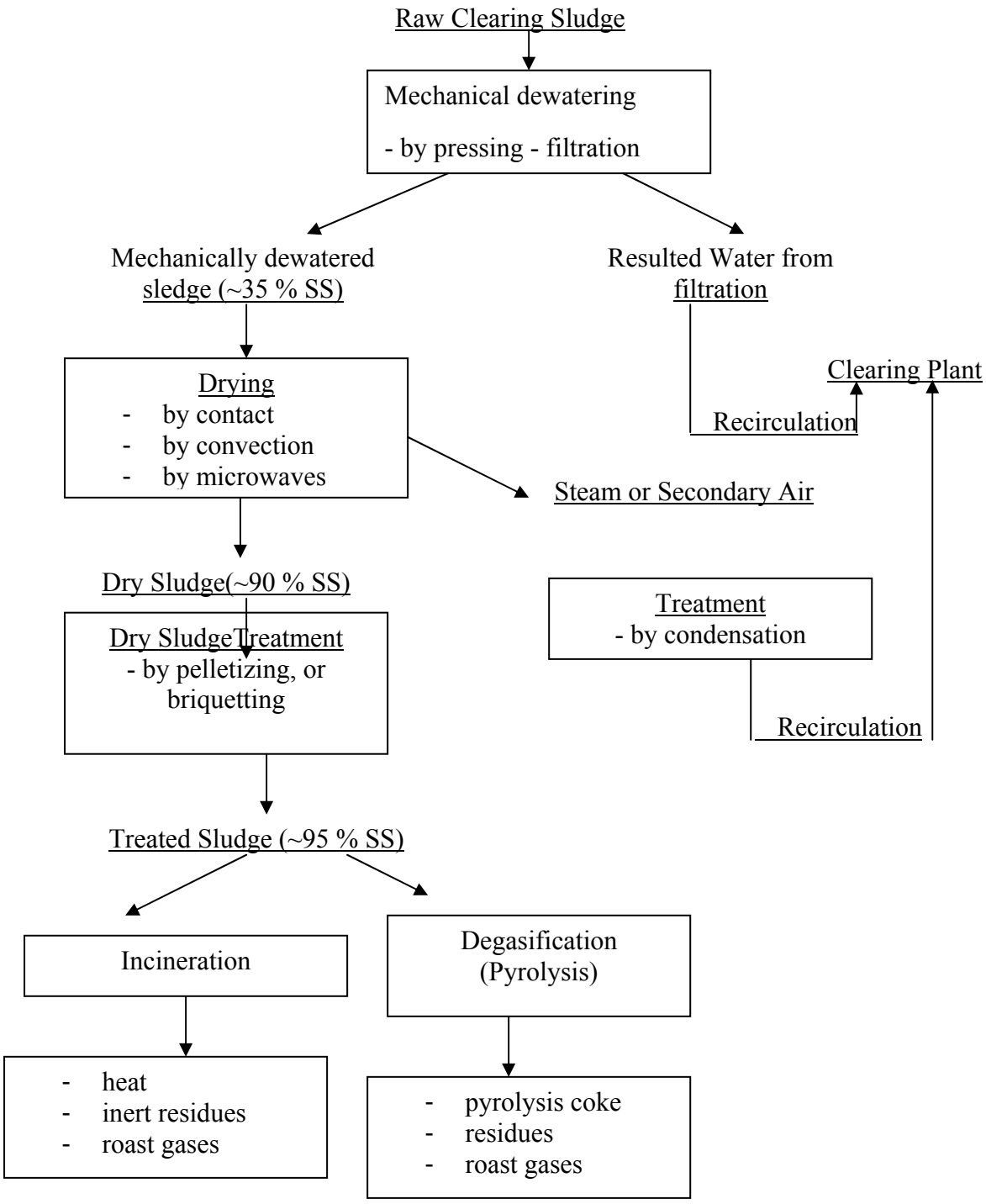


Figure 1. – Flow Chart of Clearing Sludge Treatment

While as for the sludge drying by convection and by contact a diversified range of equipment and fittings is available, the drying procedure with microwaves has not yet been performed at an industrial level. Nevertheless, the researches carried out all over the world were successful.
Such concerns arose in Romania too at the Technical University of Cluj-Napoca where people have performed researches concerning the dewatering and the drying of the clearing sludge in a microwave field in the laboratory fittings – designed and conceived at a frequency of 2,450 MHz and at a power of 5.5 kW

2. ISSUES CONCERNING THE TREATMENT OF CLEARING SLUDGE IN A MICROWAVE FIELD

The researches performed aimed at:

- studying the heating power from the point of view of the dielectric properties of sludge;
- establishing the sludge drying dynamics in a microwave field
- elaborating a flow chart of thermal treatment in a microwave field of the clearing sludge.

As far as the heating power of sludge in microwave field is concerned, the most important evaluation parameter is considered to be the effective loss coefficient namely the multiplication $\varepsilon_{ef} = \varepsilon_r \cdot tg\delta$ between the relative permittivity ε_r and the dielectric phase angle tangent $tg\delta$. The experiments performed underlined the influence of the sludge's degree of moisture on the relative permittivity and the effective loss coefficient. The results obtained are shown in Figure 2.

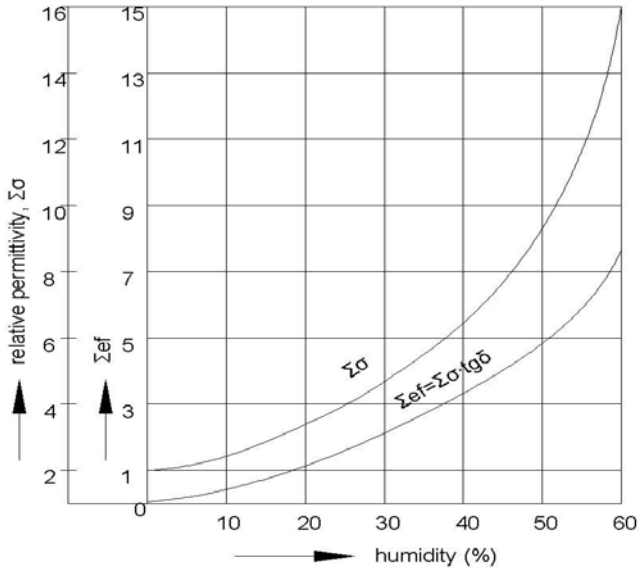


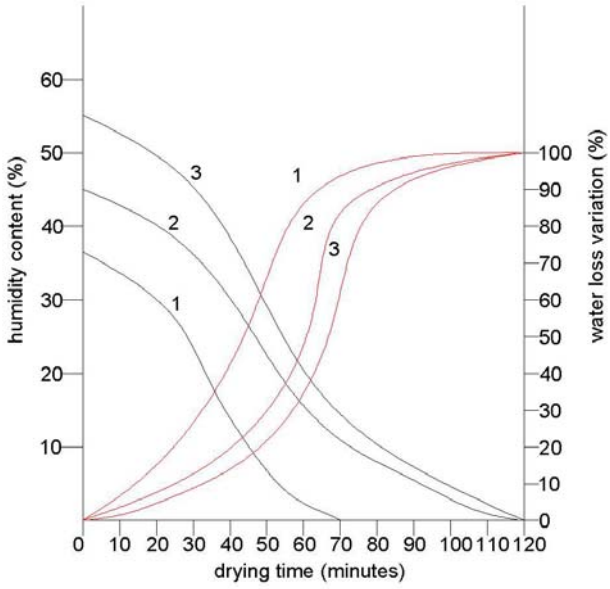
Figure 2. – Variation of the Relative Permittivity and Effective Loss Coefficient According to the Degree of Moisture of the Sludge.

We have noted that the higher values of sludge moisture the higher relative permittivity and the higher the effective dielectric loss coefficient. Knowing the value of the dielectric loss coefficient allows us to establish the intensity of the electrical field (E) for a frequency (f) considered as constant and which is necessary to provide the optimum field intensity in the sludge (expressed in the relation $W_0 = 0.556 \cdot 10^{-10} \cdot f \cdot E^2 \cdot \varepsilon_r \cdot tg\delta$, in W/m^3).

In order to determine the sludge drying in microwave field we have aimed at determining the drying time considering the different degrees of moisture of the clearing sludge.

The experiment data obtained are shown in Figure 3.

Figure 3. – Variation of the Moisture Contents According to the Drying Time of Sludge in Microwave Field (1 – Sludge Sample With an Initial Moisture Of 36 %; 2 – Sludge Sample with an Initial Moisture Of 44%; 3 – Sludge Sample with an Initial Moisture Of 57%).



It can be seen an extremely favorable behavior of clearing sludge in microwave field as dewatering is achieved after a relatively short period reaching moisture values under 0.5 %.

Based on the researches performed on the peculiarities of the heating process in microwave field of clearing sludge, a chart flow of their treatment has been established according to Figure 4.

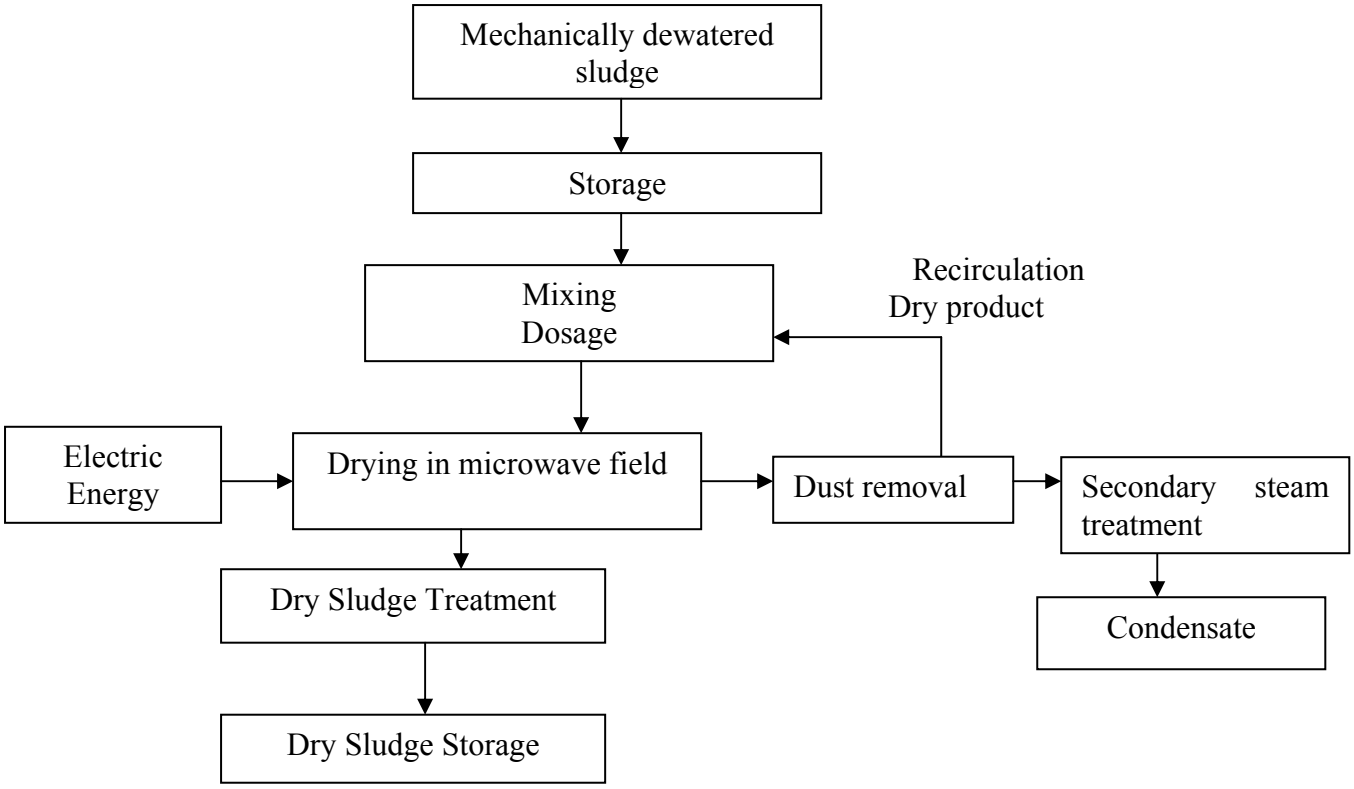


Figure 4. – The Flow Chart of Thermal Treatment in Microwave Field of Clearing Sludge.

The mechanically dewatered sludge is transported at a constant volume by means of a vane-type pump in the resonance cavity of the microwave plant. The microwave energy in the resonance cavity acts directly on the quantity of sludge in the whole volume. From the drying oven dry sludge is transported in the dry sludge treatment plant, and the dust particles mixed with the water vapors are directed to the dust removal plant.

3. CONCLUSIONS

The heating technique using microwaves represents an alternative to the classical heating systems of clearing sludge.
Unlike these, when using microwave energy, heating is produced in the whole material, in all of its sections at the same time no heating medium existent.
Microwave drying represents a self-adjustable process, that is: as the water contents of the sludge diminish the microwave effect diminishes as well.
The drying technique of clearing sludge by means of microwave energy has especially favorable implications on energy consumption, process productivity and makes dewatering possible even at smaller values of moisture.

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