

# RESEARCHES ON THE DEVELOPMENT OF AN EXPERIMENTAL MODEL OF WET SATURATED STEAM DISTILLATION EQUIPMENT

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## ABSTRACT

*Distillation is a conventional method of extracting volatile oils from medicinal and aromatic plants. This is defined as a process of separating the components of a mixture that is based on the difference between the vaporization temperatures of the constituents, respectively water and oil when distilling medicinal plants. Distillation can be performed in three ways: distillation with water, by boiling the mixture of plants and water, condensation of resulting vapours and separation of oil, distillation with water and steam, in which the steam obtained by evaporating a quantity of water passes through the plant batch; steam distillation under pressure provided by an external generator, a process named in the literature and steam entrainment. The steam distillation process is applicable to many medicinal and aromatic plants that grow in our country. The extraction of volatile oils through this process depends on the different characteristics of the plants but also on the main parameters of the process, pressure and temperature, which are different.*

## INTRODUCTION

Extraction is the operation of partially or completely separating the components of a mixture based on the difference in solubility using one or more solvents [1,2,3].

The process of extracting bioactive substances from medicinal plants takes place by achieving two basic principles, namely [6]:

- ✚ ▪ Dissolution of protoplasmic substances during contact between the solvent and the shredded cells.
- ✚ ▪ The extraction itself is complex by the penetration of the solvent into the whole cells.

Modern technologies for obtaining bioactive substances from medicinal plants require: optimal extraction yields but also a superior quality of the extracted substances, quality as close as possible to their state in the plant product, [4,5].

The efficiency of conventional techniques (Soxhlet extraction, maceration, percolation, distillation) and unconventional techniques (ultrasonic

extraction, electric pulses, microwaves, supercritical and subcritical fluids, extraction solvents) depends on a large extent on the authenticity of the plants, the chemistry composition of bioactive substances, the manner and sequence of plant processing operations, the nature and volume of the solvent used for extraction, the temperature, the extraction time but also the size of fragments [5,6].

**Distillation** is a conventional method of extracting volatile oils from medicinal and aromatic plants. It is defined as a process of separating the components of a mixture that is based on the difference between the vaporization temperatures of constituents, respectively water and oil in the distillation of medicinal plants [1,7].

Distillation can be done in three ways:

- **distillation with water**, by boiling the mixture of plants and water, condensing the resulting vapours and separating the oil from water;

- **distillation with water and steam**, in which the steam obtained by evaporating a quantity of water passes through the plant batch;

- **distillation with steam under pressure** provided by an external generator, a process called steam entrainment in the literature [7,8].

The steam distillation process is applicable to many medicinal and aromatic plants that grow in our country. The extraction of volatile oils through this process depends on the different characteristics of plants but also on the main parameters of the process, pressure and temperature, which are different, [1,8].

When elaborating the execution documentation of the **E.D.A.S.U.P technical equipment** - wet saturated steam distillation equipment under pressure, was aimed to comply to the requirements in SR EN ISO 9001: 2015 „Quality management system.

Requirements”, point 8.3. "Design and development of products and services", point 8.3.3. "Design and development inputs", so that it includes as inputs:

1. Functional and performance requirements;
2. Applicable legal and regulated requirements:

- ✚ SR EN ISO 12100:2011 - Safety of machinery — General principles for design — Risk assessment and risk reduction;
- ✚ Law 319/2006 on safety and health at work, with subsequent amendments and updates;
- ✚ GEO. 195/2005 on environmental protection, with subsequent amendments and updates;
- ✚ Standards specific to the field of the project.

## MATERIAL AND METHOD

E.D.A.S.U.P wet saturated steam distillation equipment has the following main elements:

- ✚ Distillation vessel, part **E.D.A.S.U.P -3.0** - 1 piece.;
- ✚ Cooling vessel, part **E.D.A.S.U.P -1.0** - 1 piece.;
- ✚ - Steam vapour generator, part **E.D.A.S.U.P -1.0** - 1 piece.
- ✚ - Volatile oil separator, part **E.D.A.S.U.P -1.0** - 1 piece.;

- ✚ - Distillation vessel holder, part **E.D.A.S.U.P -1.0** - 1 piece;
- ✚ - cooling vessel holder, part **E.D.A.S.U.P -1.0** - 1 piece.;
- ✚ - pressure regulator, part **E.D.A.S.U.P -1.0** - 1 piece;
- ✚ Hoses for the connection between vessels and the steam generator.

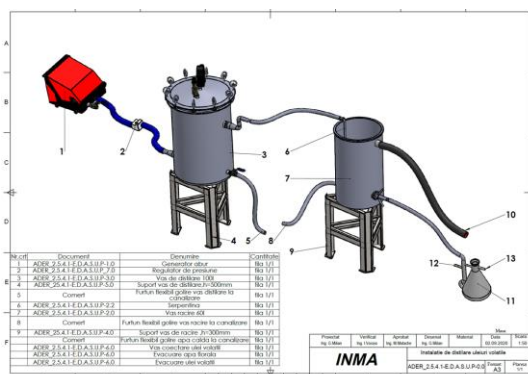


Fig.1. E.D.A.S.U.P wet saturated steam distillation equipment

The distillation vessel (fig. 2), part E.D.A.S.U.P - 3.0, is a cylindrical container made of food grade stainless steel sheet, consisting of steam inlet / outlet fittings, drain valve, sealing gasket and decompression valve. Also, the tight seal of the vessel is made by means of a lid equipped with safety valves of 0.5 bar and thermo-manometer with indicator

needle (measures pressure and temperature). Inside, the distillation vessel is provided with a sieve on which the mass of plant material subjected to the distillation process will be placed. The sieve is provided with a rod for guidance and support during the process of loading / unloading the plant material.

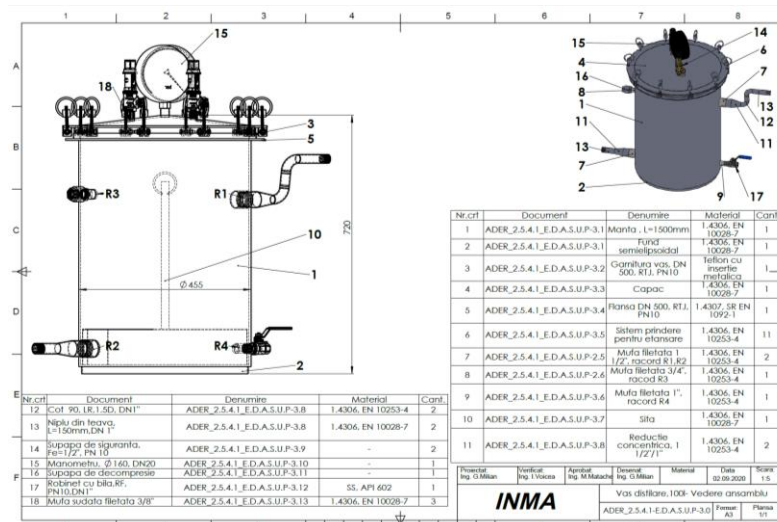


Fig.2. Distillation vessel, part E.D.A.S.U.P-3.0

The distillation vessel part EDASUP- 3.0 consists of the following main construction elements: distillation vessel sheath (fig. 3), vessel gasket, lid,

flange, RTJ, PN10, DN500, sealing clamping system (fig. 4), sieve, reduction conc. DN1 1/2 ", Elbow 90 DN 1", fitting pipe DN 1 ", safety valve.

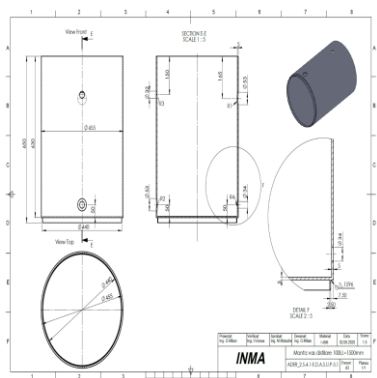


Fig.3. Distillation vessel sheath

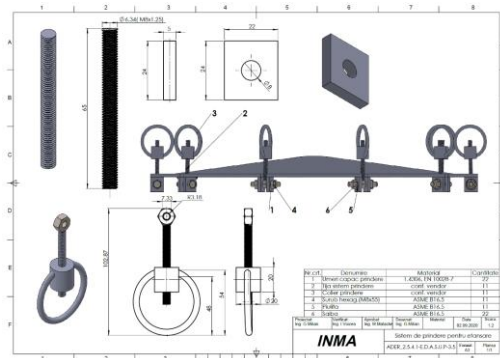


Fig.4. Clamping system for sealing

The cooling (condensation) vessel (fig. 5), is a cylindrical container made of food grade stainless-steel, having in its component a serpentine heat exchanger, connections for inlet / outlet of cooling water and drain valve. It consists

of sheath, inner serpentine through which the steam containing essential oils circulates (fig.6), coil and hose connection nozzle, coil gusset, 3/4" threaded plug, DN25 yoke type support.



Fig.5. Cooling (condensation) vessel

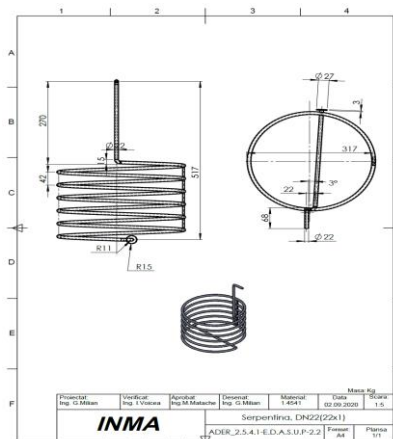


Fig.6. Serpentine

## RESULTS AND DISCUSSIONS

**Volatile oil collection vessel or volatile oil separator** (fig. 7), part number EDASUP-6.0, is a container made of glass, being provided with an inlet connection, a floral water collection connection and an outlet connection with nozzle for collecting volatile oil.

PULSE 7K electric steam generator, supply voltage 400 V, power consumption 7000 W, degree of protection IPX5, supply flow 3 l / min, supply pressure max. 6 bar, size and weight: Length 920 mm, Width 610 mm, Height 850 mm, weight 70 kg.

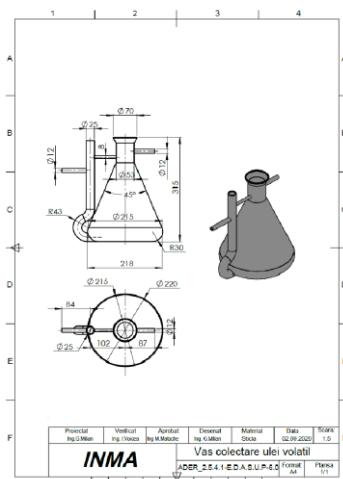


Fig.7. Volatile oil collection vessel

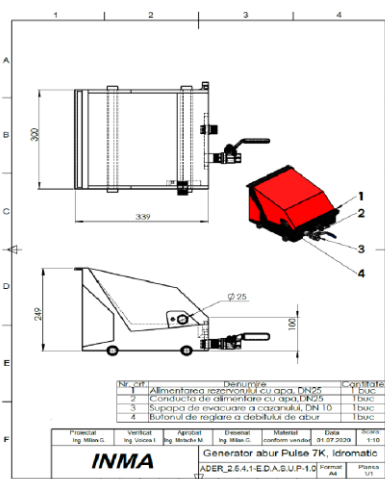
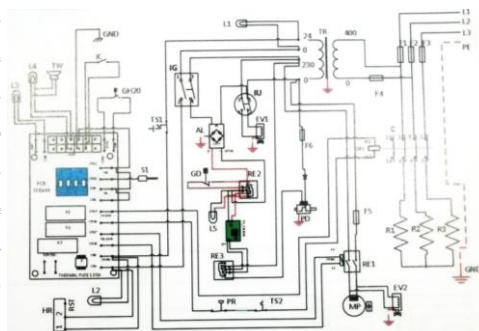


Fig.8. PULSE7K Electric steam generator + electric diagram



The main technical characteristics of the presented equipment are highlighted below:

- Working capacity 100 l;
- Distillation vessel 400 mm;
- Distillation vessel height 700 mm;
- Cooling vessel diameter 400 mm;
- Cooling vessel height 600 mm;
- Working pressure:

Low pressure 0.10-0.5 bar;  
- Working temperature 105-110 °C

**Electric steam generator:**

- ⚡ supply voltage 400 V
- ⚡ power absorbed 7000 W
- ⚡ protection degree IPX5
- ⚡ feeding rate flow 3 l/min
- ⚡ supply pressure max. 6 bar
- ⚡ dry steam flow 11.5 kg/h

✚ water pump	110 W	✚ weight	70 kg.
✚ water tank capacity	30 l.		
✚ size and weight: length 920 mm, width 610 mm, height 850 mm			

## CONCLUSIONS

The steam supplied by the generator crosses the vegetable mass of the plants, entraining the volatile oil contained by them, after which the mixture of steam and volatile oil enters the cooling vessel where the condensation process takes place, obtaining a mixture of volatile oil and floral water. The separation into fractions of the mixture of volatile oil and floral water is performed in the volatile oil separator, based on the difference in density between the two fractions.

The collection of volatile oil is made at the top of the separator and the floral water is collected at the special connection intended for this purpose. From a nutritional point of view, plant extracts can have a fertilizing effect, but the use of plant extracts only as a source for fertilization is not economically feasible. However, the use of these extracts can contribute to changing the balance of microbial populations in the soil by giving the plant a competitive advantage for existing mineral resources.

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This advantage is manifested by a vigorous growth of the plant and an increased accumulation of biomass producing effects similar to fertilizing the soil with macro elements.

The "bio-fertilizer" effect of plant extracts is the result of a complex interaction process between the crop plant, the soil considered as a common nutritional substrate and microbial populations.

The "bio-insecticide" effect of plant extracts is due to a natural substance in the composition of the plant. Among the actions of plant extracts on plants are: the repellent action, through which insects are driven away: the repellent action by which insects are discouraged; the anti-feeding action, through which insects do not consume food; the disruptive action of prolificacy, through which insects are confused. All these actions lead to a decrease in the number of pest populations at the same time with a very low chemical footprint on the crop, giving agriculture an ecological characteristic.

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