FlashDrier® FlashReactor®

ALTERNATIVE TECHNOLOGIES TO TRADITIONAL PROCESSES

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Examples of applied research

The Industrial Plants and Processes Division of VRV S.p.A. has been operating for some years in the desi gn and manufacture of dynamic and turbulent thin-layer high speed centrifugal reactors and driers, based on the "Flash System" technology and successfully utilized in different industrial fields under the trade marks of "Flash Reactors" and "Flash Driers".

Both machines are the result of exhaustive research carried out in VRV laboratories on pilot plants, with the main purpose of creating a drying system (or reaction and drying), that could represent a valid alternative to the existing systems traditionally used in this specific sector.

The interest that the market has reserved to this innovative tecnology, protected by patents granted in Italy, Europe and the U.S., confirms that the result set has been achieved, particularly for those products difficult to treat for thermosensitivity, high viscosity, transitory plasticity, toxicity etc...

As mentioned, the machines utilize the mechanical centrifugation to create, inside the plant, thin-layer, dynamic and turbulent in atmosphere of air, gases, vapours or vacuum product conditions.

The basic structure of each machine, similar for all models, mainly consists of a horizontal cylindrical stator, provided with thermal jackets, inside and coaxially to which operates, with tip rotation speed up to 35 m/s, a cylindrical rotor equipped with adjustable elements of product centrifugation, agitation and feed.

Thermal jackets, that can be divided and connected in series or in parallel, can operate up to the maximum temperature allowed by the characteristics of the heating fluid (i.e. 300-350°C for diathermic fluids), and can be used only in heating or also heating-cooling configuration.

Thermal exchange mainly takes place by conduction (though mixed configurations are possible: conduction/convection); in fact the advantage of operating under product conditions with a particularly turbulent thin-layer enables to obtain wall exchange coefficients, and thus extremely interesting thermal flows, higher than those achievable with other known systems.

This fact is fundamental for vacuum treatments, since thermal exchange, lacking other vehicles like air or gas, is necessarily to take place by conduction.

We illustrate, by means of examples taken from processes and plants created industrially, how the characteristics of "Flash Drier" can be favourably used as an alternative to the technologies traditionally used in drying or reaction-drying processes like:

- Drying of dyes
- Drying of surfactants
- Saponification of fatty acids.

Fig. 1 - Flash Drier mod. FD 4/20, general view

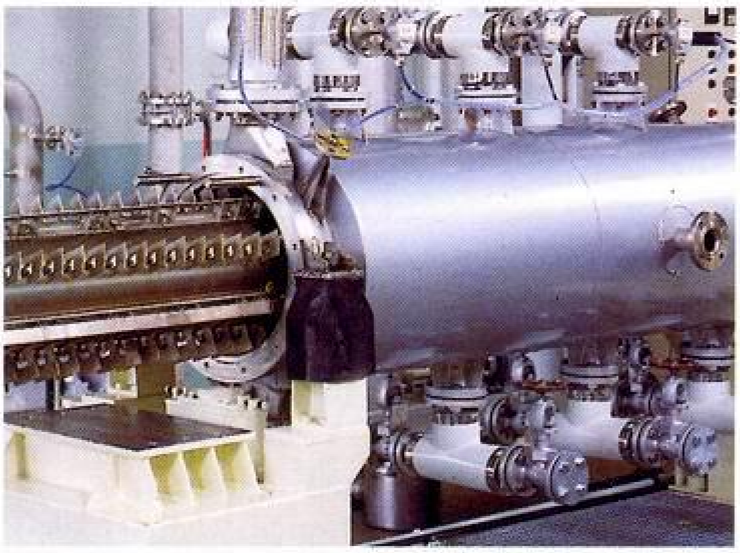


Fig. 2 - Flash Drier mod. FD 4/20, rotor detail

Example 1 - DRYING OF ORGANIC DYES

Let's examine briefly the manufacturing stages to obtain a common organic dye once, starting from specific raw materials and through diazotization, coupling, condensation, sulphonation operations etc..., the raw material has been obtained in purified solution or suspension.
As shown in block diagram No. 1, the stages provided for are the following:
- filtration
- drying
- breaking
- grinding
- setting up

With the first stage, the greatest possible quantity of solvent is eliminated from the dyed substance through filter-pressing, thus the press-cake, placed in containers, is introduced into static driers operating under vacuum. The operations are carried out in batch and the drying time never exceeds 24 hours. The additional breaking and grinding operations are necessary to bring the dried substance, within the limits of the granulometry required.

Also setting up is necessary in that, with the operations carried out in batch, different batches of the same product are to be mixed together, so as to reach uniformity and repeatability conditions ensuring dyeing characteristics and optimal applications.

On the contrary, by using the "Flash Drier" the operations described above are replaced by a single process stage, contemporarily carrying out drying and breaking continually, automatically and in a reproducible way, with a remarkable technological improvement.

For example, the danger of cross contamination, that with static driers is frequently present, owing to objective difficulties in cleaning the numerous machines and equipment necessary to the process, is practically eliminated.

With the "Flash Drier" the setting up times of the plant are considerably reduced; it is possible to obtain residual humidity values in the dried product, that are unlikely to be achieved with static driers.

Even environmental hygiene is consderably improved in that, being breaking and grinding operations no longer necessary, dust collection systems are eliminated and consequently also the dustiness degree of the environments.

The continuous process has also proved to be very versatile, enabling to achieve the degree of humidity desired in the finished product, yet feeding pasty substances with a solvent content of 50% or fluid solutions containing up to 80% of solvent.

An additional advantage lies in the possibility to choose the plant configuration that better fits in with the chemical-physical characteristics of the product treated:
- under vacuum, for thermosensitive or thermolabile products, with possible fluxing of inert gas,
- at atmospheric pressure, for products resistant to temperature and that can be used with oxygen,
- in controlled atmosphere, when the dyes and solvents are not compatible with the presence of oxygen or when there exists the risk of formation of explosive mixtures.

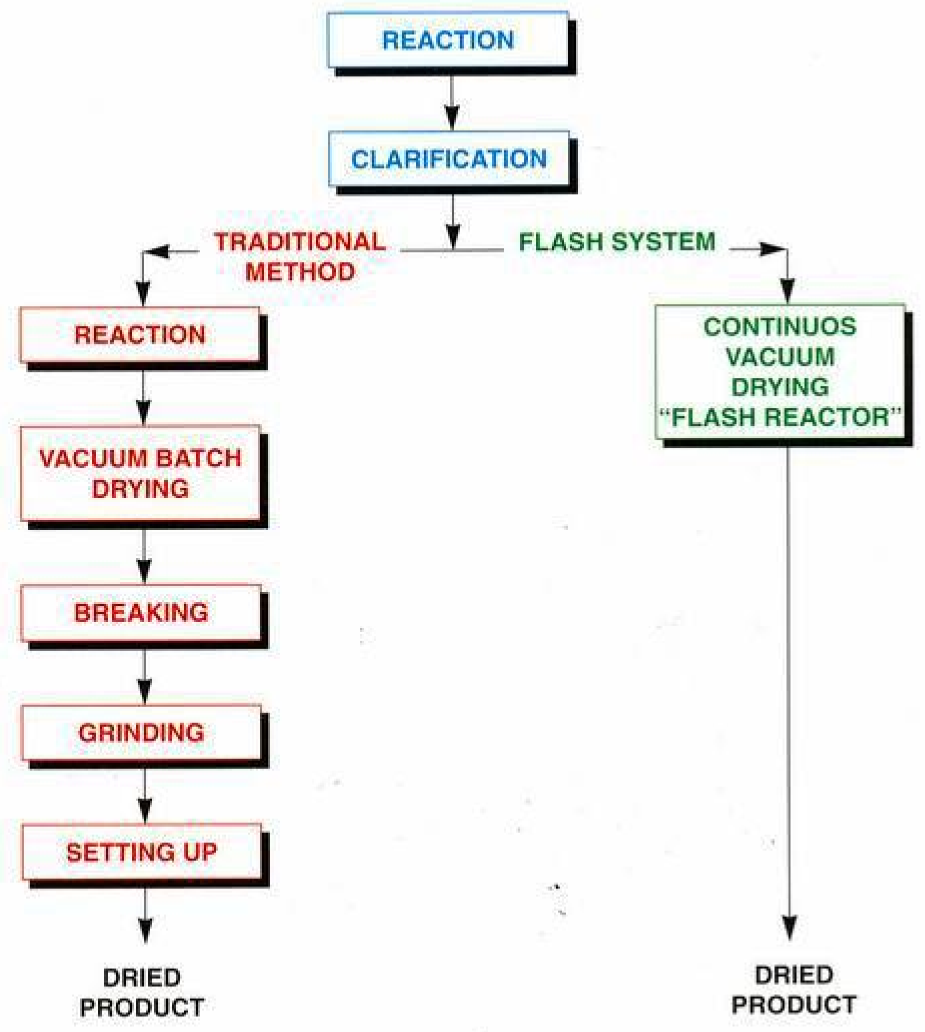


DIAGRAM 1 - DYES DRYING

Example 2 - DRYING OF SURFACTANTS

Surfactants are substances that naturally have wetting, cleaning, foaming, emulsifying properties etc... and are used in large quantities in different industrial sectors. Among the best-known:
- in detergents for domestic use (in powders, liquids or solids)
- in the products meant for personal care (shampoo, bubble baths, toothpastes etc...)
- in the textile, oil, chemical industry and where a substance with the aforesaid characteristics is necessary.

According to the category they belong to (anionic, nonionic, cationic or amphoteric substances), surfactants call for particular conditions for possible thermal drying, since each category has very different thermosensitivity characteristics.

Among the different drying processes known, we shall describe the most traditionally common one, lying in the drying of the surfactant in hot air current.

The block diagram No. 2 illustrates the main drying stages of a surfactant, that consist in sending into a vertical cylindrical chamber (generally of large dimensions) a flux of wet product encountering, co-current or counter-current, a flux of hot air . Drying takes place by convection and hot air is produced through liquid or gaseous fuel heat generators.
Air circulation in the drying circuit takes place through one or more fans and the exhaust air, before being released into the atmosphere, is to be filtered through sleeve filters.

Feeding of the product to be dried usually takes place by pressure and, according to the type of tower, is connected to a spray nozzle circuit or to a disc turbine.
The physical appearance of a product, that is dried in a tower, is that of a low bulk density powder. Just after the outlet from the tower, it is sent to a plodder that, through compression, compacts and subsequently extrudes it in the shape of cylindrical little needles. The product obtained is thus cooled and sent for storage.

Unlike spray towers, in the "Flash Drier", drying takes place by conduction. Moreover, it is possible to choose the type of configuration of the process circuit (atmospheric or under vacuum) according to the thermosensitivity characteristics of the product to be dried. Through such method, the dried product appears in the shape of granules or powder with good characteristics of flowability, humidity and high bulk density. Having suffered no type of compression, the dried granule forms through breaking up of the starting wet product and subsequent granulation, so it preserves that natural microporosity that accentuates and favours its rapid and complete dissolution in the solvent.

Drying by conduction considerably increases the system thermal efficiency, in that it avoids hot air (that, on the contrary, represents the only thermal vehicle in spray towers) with the result of obtaining considerable energy saving, even in terms of heat lost for dispersion.

Safety cannot certainly be neglected. It is well-known that thermosensitive products treated in tower can easily suffer degradation and, particularly, spontaneous combustion: in the "Flash Drier" the reduced product mass in the drier, the extremely short residence times, the possibility to flux with inert gases or treat under vacuum, are to be considered as optimal conditions to increase operational reliability and reduce the risk of undesired phenomena.

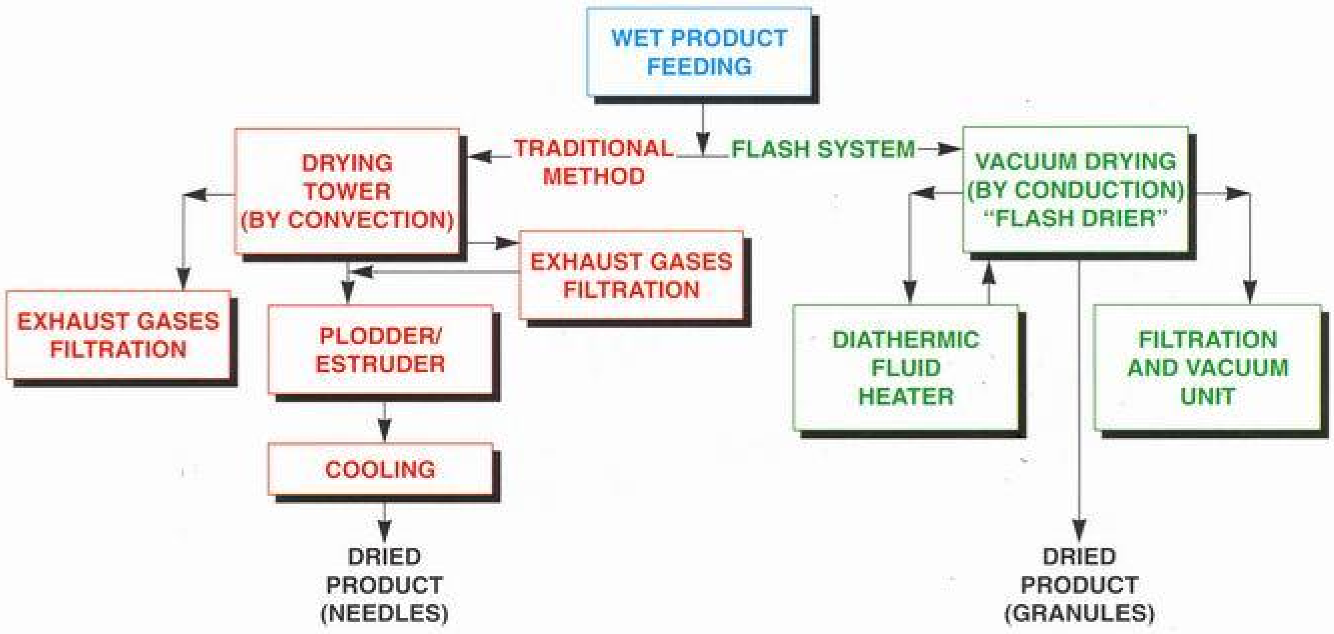
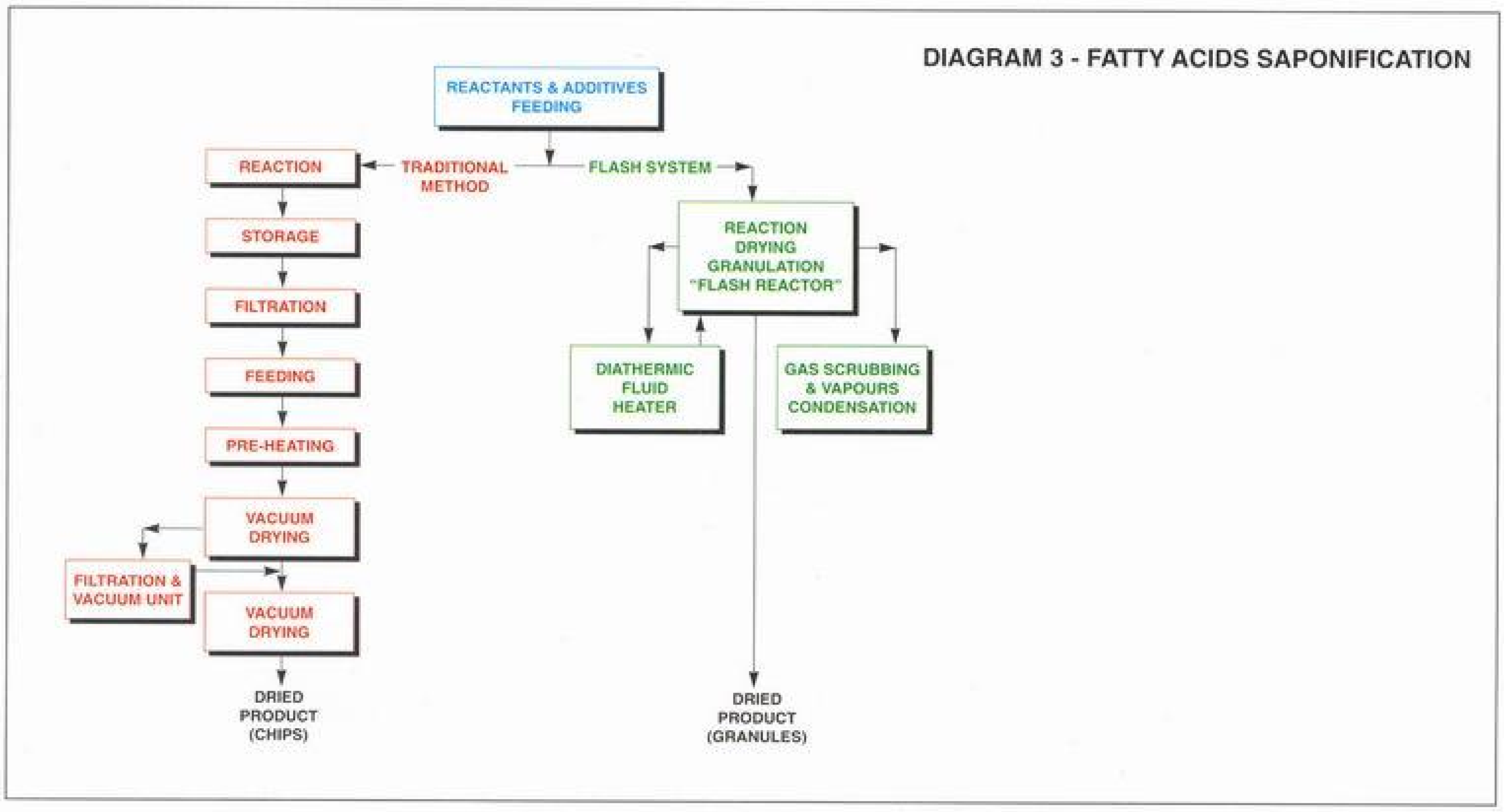


DIAGRAM 2 - DRYING OF SURFACTANTS



Example 3 - SAPONIFICATION OF FATTY ACIDS

A traditional saponification plant, whose raw materials are fatty acids and reagents, generally consists of three units connected in series.

- Saponification unit
- Drying vacuum unit
- Finishing line

The first unit provides to the neutralization of fatty acids, by feeding raw materials suitably dosed in a saponification reactor that, in turn, feeds by overflow a holding mixer.

The neat soap produced is a paste, which is to be subsequently dried under vacuum.

In the drying unit neat soap, fed by pump, is heated in a heat exchanger and thus sprayed in a vacuum drying chamber.

The lower part of the chamber is connected to a plodder, which extrudes soap in the shape of noodles.

The vacuum necessary to the drying chamber is generally produced by a system composed of a vapour ejector, a barometric condenser and a vacuum pump.

The noodles produced by the drying unit are sent, through pneumatic conveyance, to the finishing line.
By comparing the traditional saponification process with the "Flash Reactor", it is immediately possible to point out that, while in the first case the process has three different stages, namely:

- Reaction
- Drying (under vacuum)
- Noodle formation

in the "Flash Reactor" process these three stages take place in a single stage and at atmospheric pressure (see block diagram No. 3).
Generally speaking, the limiting factor, to obtain the widest range of possible reactions, is the reaction speed, which highly depends on the mutual solubility of the participants to the equilibrium and also on the difficulty in carrying out a close contact between the reagents, so as to overcome the chemical-physical difficulties.

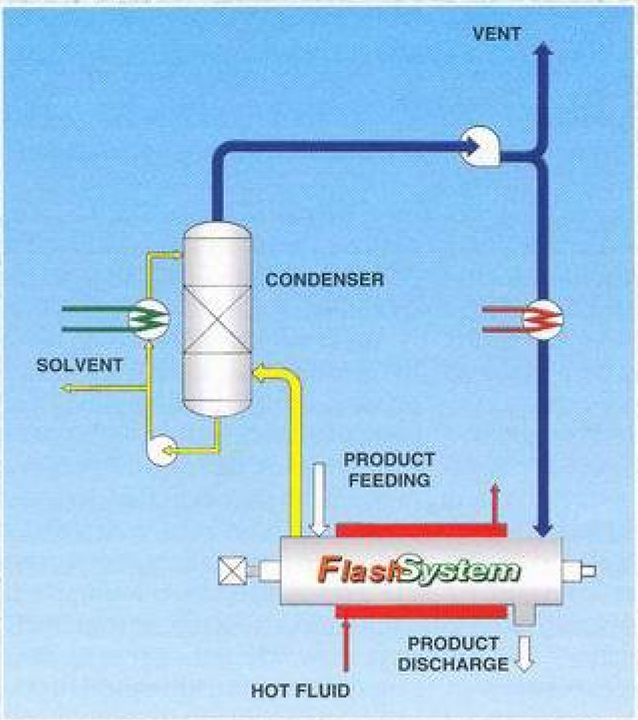
The "Flash Reactor" represents an innovative technological solution, in that it is able to carry out a close contact among the materials participating in the saponification reactions.

In fact, through such system, it is possible to carry out simultaneously, even if in separate parts of the system, a close mixing action and, therefore a shift in the chemical balances, on the basis of the mass action law, a displacement of the reacted masses from the primary reaction site, a variation in water concentration, which always affects balances and finally physical stabilizing actions on the final products.

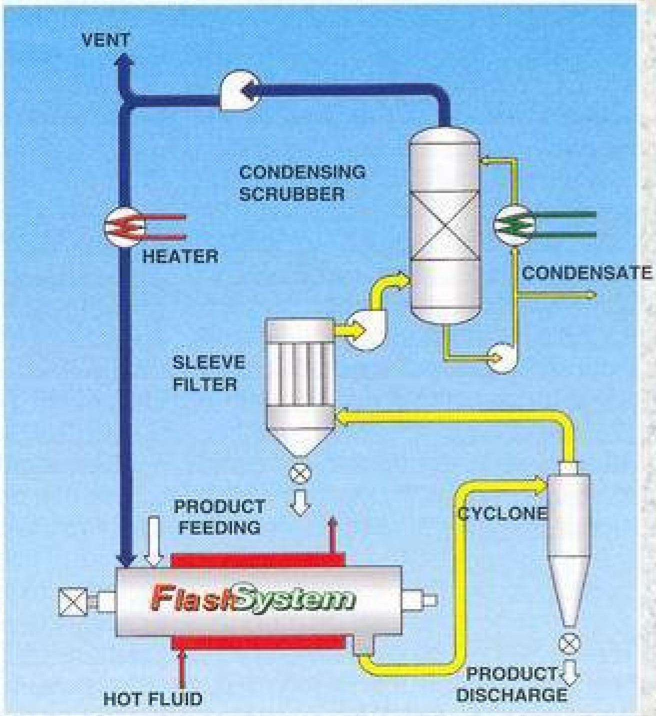
To all these aspects, it has to be added a high thermal exchange capacity, that can be adjusted along the longitudinal direction of the process, which reaches every reaction site owing to the thin layer distribution of the reactants.

From a qualitative point of view, the soap produced with the "Flash Reactor" is generally comparable to the one produced with the traditional method, moreover the "Flash Reactor" lends itself to many applications, both in the oil sector and in the detergent field, supported by its versatility, the favourable energy balance and finally the favourable ecological implications deriving from the simplicity of the operations it can perform.

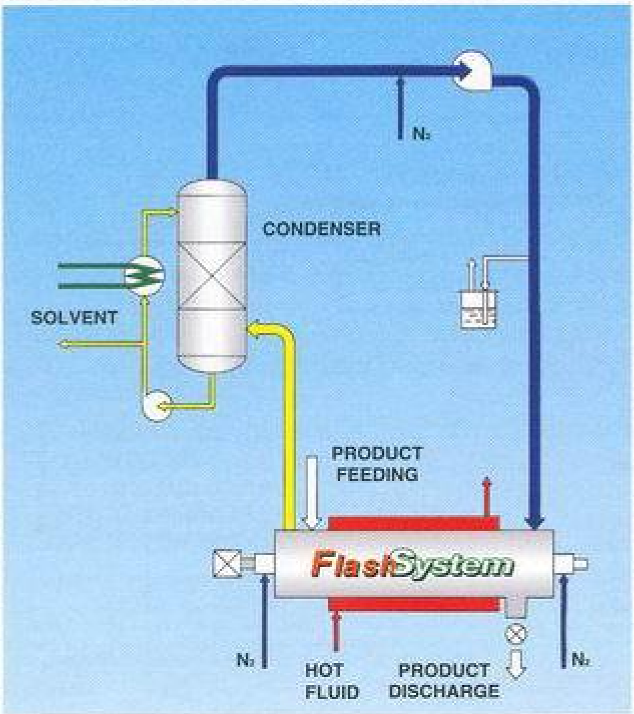
1. COUNTERCURRENT ATMOSPHERIC CIRCUIT



2. CO-CURRENT ATMOSPHERIC CIRCUIT



3. BLANKETED CIRCUIT



4. UNDER - VACUUM CIRCUIT