# *Production of Emulsions - Overview of Manufacture*

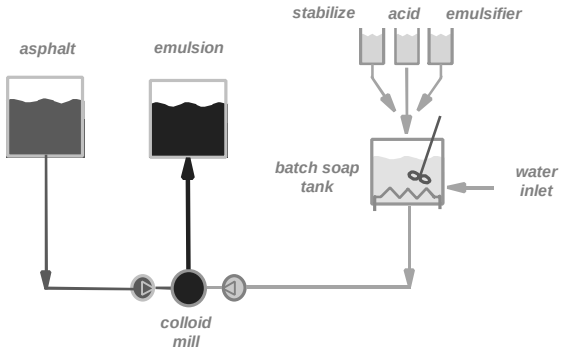
An asphalt emulsion plant can be either a batch type or continuous and in most cases incorporates a colloid mill. In the manufacturing process, an emulsifier solution (soap) and hot asphalt are passed through the colloid mill, where the emulsification takes place. The soap solution contains water, emulsifier, acid or base and if required a stabilizer such as calcium chloride, which are carefully mixed in such proportions that a uniform solution with the right pH is obtained. A solvent such as naphtha, mineral spirits, kerosene or diesel oil, is often also part of the emulsion. It can be mixed in with the asphalt, the emulsifier solution or the emulsion after the colloid mill. Polymers in latex form such as natural rubber or SBR may be incorporated preferably in the soap phase or to the emulsion after production. Polymers such as SBS or EVA are pre-dispersed in the asphalt phase.

Before production starts, a formulation is optimized in the laboratory to give a suitable emulsion with regard to performance in the application and specification.

### *Batch Plants*

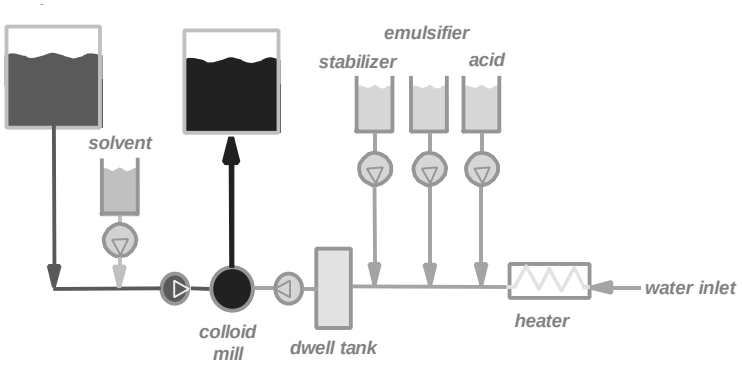
In a batch plant, the emulsifier solution (soap) is prepared and brought to temperature in a batch tank. If solvent is to be used and if it is to be added to the asphalt, then a batch tank is needed for the asphalt as well, or the solvent will have to be dosed in-line. The asphalt and water can be measured by using a level gauge on the tank. The small volume materials, i.e. solvent and the chemicals should be weighed or metered in by a more sensitive device.

Batch Plant




In the simplest batch plants the asphalt and soap batches are prepared in the volumes corresponding to the desired asphalt residual and then gravity-fed through the colloid mill until the batch tanks are empty. A much better set-up includes dosage pumps making it possible to keep the desired residual through the whole production, giving a better end-quality.

In-line Plant




***In-line Plants***

The in-line plant has no batch tanks; asphalt and emulsifier solution come directly from the supply. The soap is prepared automatically and in accordance with the selected formulation by injecting emulsifier, acid and stabilizer into the water line, where the reaction between the emulsifier and the acid takes place before the water enters the mill. The water is heated to suitable temperature by a continuous heater. Heat can be recovered from the emulsion cooler. The continuous plant requires emulsifiers that easily disperse in water in order to allow fast reaction with acid or alkali. A pH-probe, attached to the water line just before the mill, controls the dosage of the acid or alkali.

The asphalt and (if required) solvent are also continuously fed to the mill. The asphalt is kept in a tank at correct temperature. The continuous plant can run as long as there are material and storage space available. The main advantages of continuous plants over batch plants are:

- Quick change from one emulsion type to another
- Less labor and lower handling costs are required
- Health hazards related to the handling of chemicals are almost eliminated
- Higher utilization by elimination of the time required to prepare for batches
- Heat can be recovered simply from the emulsion *via* a cooler and used to heat the incoming water. In a batch plant this heated water needs to be stored until the next soap production.

***Production of Emulsions - Temperature and Pressure***

In unpressurized systems the temperature of the emulsion must never reach 100°C (*212°F)* during manufacturing and should be kept between 85°C (*185°F*) and 95°C (*200°F).* In order to avoid local overheating the temperature difference between the asphalt and the emulsifier

solution should be kept as small as possible. However, the asphalt must be sufficiently hot to be pumped.

*Asphalt-phase Temperature*
The viscosity of the asphalt phase should be between 250 - 350 cSt in order to allow pumping into the emulsion mill. This means that the temperature will be different for different grades of asphalt.

| | | |
|---|---|---|
| Example: | pen 180/200 | 125-135°C *(260-275°F)* |
| | pen 80/100 | 135-145°C *(275-290°F)* |
| | pen 50/70 | 140-150°C *(285-300°F)* |

*Soap-phase Temperature*
The soap phase temperature can be calculated from the following formula:

$$Tw = Te + (Te - Tb) \cdot Cpb / Cpw \cdot b / w$$

| | | | | |
|---|---|---|---|---|
| Te | = | Temperature of emulsion °C | Tb | =Temperature of asphalt °C |
| Cpb | = | Heat capacity of asphalt | Cpb | = 1.90 kJ/°C/kg |
| Cpw | = | Heat capacity of water-phase | Cpw | = 4.18 kJ/°C/kg |
| w | = | % water-phase | b | = % asphalt-phase |
| Tw | = | Temperature of water-phase °C | | |

The temperature of the water-phase must be high enough to have sufficient blending and reaction between emulsifier and acid. 40-50°C *(104-122°F)* is normally sufficient. This is especially important in an in-line plant where there is a limited time available before emulsification. The formula has been used to calculate the maximum soap phase temperatures for an emulsion exit temperature of 90°C *(195°F),* suitable for unpressurized systems (see table on next page).

***Material Dosage by Temperature Control***
Many batch plants are run by temperature control. When this is the case, the temperatures of the asphalt, water-phase and emulsion are measured and compared to find out the material balance, i.e. the asphalt residue of the emulsion.

***Back Pressure and/or Emulsion Cooling***
If an emulsification temperature above the boiling point of water is required, for example when using polymer-modified asphalt, back pressure and an emulsion cooler are always needed. A back pressure is needed to keep the water from boiling. The emulsion must be cooled down to around 90°C *(195°F)* before the pressure is lowered. For a temperature of 110°C *(230°F)* a

back pressure of 0.5 bar is required, whereas for a temperature of 120°C *(250°F)* a back pressure of 1 bar is needed.

***Akzo Nobel Emulsion Plants***

Akzo Nobel offers a range of emulsion plants, both batch and in-line design, suitable for all emulsion producers. Features of the plant include the very highest quality materials including corrosion-resistant alloys, closed systems for safe handling of chemicals (even for batch plants), and a range of optional instrumentation and automation packages from simple manual controls and flow control based on temperatures to sophisticated remote production control systems. For information on Akzo Nobel emulsion plants and related equipment ask for the booklet "Bitumen Emulsion Plants".

*Maximum Soap Temperatures for Unpressurized Colloid Mills*
*(Exit Temperature 90°C)*

| ***Asphalt %*** | ***Asphalt Temperature °C / °F*** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ***125 /257*** | ***130 /266*** | ***135 /275*** | ***140 /284*** | ***145 /293*** | ***150 /302*** | ***160 /320*** | ***170 /338*** | ***180 /356*** |
| ***55*** | 71 */159* | 68 */154* | 65 */149* | 62 */144* | 59 */139* | 57 */134* | 51 */124* | 46 */114* | 40 */104* |
| ***56*** | 70 */158* | 67 */152* | 64 */147* | 61 */142* | 58 */137* | 55 */132* | 50 */121* | 44 */111* | 38 */100* |
| ***57*** | 69 */156* | 66 */151* | 63 */145* | 60 */140* | 57 */134* | 54 */129* | 48 */118* | 42 */107* | 36 */96* |
| ***58*** | 68 */154* | 65 */149* | 62 */143* | 59 */138* | 55 */132* | 52 */126* | 46 */115* | 40 */104* | 34 */92* |
| ***59*** | 67 */153* | 64 */147* | 61 */141* | 57 */135* | 54 */129* | 51 */123* | 44 */112* | 38 */100* | 31 */88* |
| ***60*** | 66 */151* | 63 */145* | 59 */139* | 56 */133* | 53 */127* | 49 */120* | 42 */108* | 35 */96* | 29 */84* |
| ***61*** | 65 */149* | 62 */143* | 58 */136* | 54 */130* | 51 */124* | 47 */117* | 40 */104* | 33 */92* | 26 */79* |
| ***62*** | 64 */147* | 60 */141* | 57 */134* | 53 */127* | 49 */121* | 46 */114* | 38 */101* | 31 */87* | 23 */74* |
| ***63*** | 63 */145* | 59 */138* | 55 */131* | 51 */124* | 47 */117* | 44 */110* | 36 */96* | 28 */83* | 20 */69* |
| ***64*** | 62 */143* | 58 */136* | 54 */129* | 50 */121* | 46 */114* | 42 */107* | 33 */92* | 25 */78* | 17 */63* |
| ***65*** | 60 */141* | 56 */133* | 52 */126* | 48 */118* | 44 */110* | 39 */103* | 31 */88* | 22 */72* | 14 */57* |
| ***66*** | 59 */138* | 55 */130* | 50 */123* | 46 */115* | 41 */107* | 37 */99* | 28 */83* | 19 */67* | 11 */51* |
| ***67*** | 58 */136* | 53 */128* | 48 */119* | 44 */111* | 39 */103* | 35 */94* | 25 */78* | 16 */61* | |
| ***68*** | 56 */133* | 51 */124* | 47 */116* | 42 */107* | 37 */98* | 32 */90* | 22 */72* | 13 */55* | |
| ***69*** | 55 */130* | 50 */121* | 44 */112* | 39 */103* | 34 */94* | 29 */85* | 19 */67* | | |
| ***70*** | 53 */127* | 48 */118* | 42 */108* | 37 */99* | 32 */89* | 26 */79* | 16 */60* | | |
| ***71*** | 51 */124* | 45 */114* | 40 */104* | 34 */94* | 29 */84* | 23 */74* | 12 */54* | | |

For example: If the asphalt temperature is 140°C *(284°F)* and the target residue is 62% then the soap phase should be heated to maximum 53°C *(127°F).* Note: Certain emulsifiers may require higher water phase temperatures for solubility.