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CSE-XR® Mixer-Heat Exchanger

in the Polymer Processing Industry

In polymer production and processing steps Fluitec's mixer-heat exchanger CSE-XR® are increasingly used to heat or to cool the polymer melts or dissolved polymers.
The new CSE-XR® of the 3rd generation, however, opens even more possibilities for innovative and economic applications in the polymer industry. This abstract describes selected fields of current applications.

Functional Principle
The unique and patented geometry of the CSE-XR® mixer-heat exchanger can be generated by replacing the common Schaschlik-elements of a multi-tube heat exchanger by static mixing elements of type CSE-X®. The polymer will then be pushed through the double-shell space, while the heat transfer media flows inside the numerous small tubes (opposite way if compared to conventional multi-tube heat exchangers).
The resulting radial mixing efficiency is extremely high and the fact, that the polymer must not be divided in many single parallel flows leads to a very homogeneous heat exchange. Maldistribution or even plugging of individual tubes, caused by changes in the viscosities as it often occurs in multi-tube heat exchangers, is consequently avoided and even a plug-flow like residence distribution is achieved. In addition, the CSE-XR® mixer-heat exchanger has a great specific heat exchanging area, thus making this device particularly suitable for the processing of highly viscous and temperature sensitive media, such as polymers.

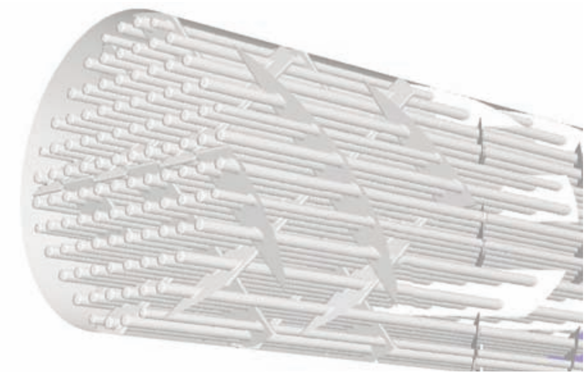

Fig. 1 CSE-XR® mixer-heat exchanger

Chemical Fibres
The processing steps for the production of chemical fibres are mostly as follows: special high-pressure polymer pumps press the melt through nozzles of very small diameters (spinneret); the resulting fibres are bundled and stretched over godets before they are winded-up in a collet.

It is easy to understand that a very reliable technique is required, which is stable over long terms. Among the most important parameters to control are the residence time distribution, the temperature profile and the homogeneity of the polymer melt. If producing e.g. polyester fibres (e.g. PET), the optimal temperature in the last section of a polymerisation reactor (finisher) is even higher than in the spinneret. This is the reason why efficient coolers are needed between the continuous polycondensation unit and the spinneret. This cooling process is not only very demanding by itself, but also a very high homogeneity of the temperature profile over the cross-sectional area must be guaranteed at any time. A higher quality of the polymer melt improves the product quality, increases the maximum throughput rate and allows the use of longer piping with longer residence times of the polymer. The CSE-XR® mixer-heat exchanger is dedicated to process cellulose based polymers (e.g. viscose) as well, as synthetic chemical fibres (e.g. polyamide, polyester and polyethylene). It is not only used in new plants, but also to improve the performance of production plants which are already running.

Fig. 2 CSE-XR® to cool fibres (PN320)

Adhesive Films and Tapes

An uniformly distributed adhesive on films and tapes is the precondition for products of high quality. A constant temperature and a very homogeneous temperature profile (+/- 1 to 2°C) in the production process helps to control the viscosity and thereby also the thickness of the adhesive applied. Due to its compact design and the unrivalled mixing performance, the CSE-XR® mixer-heat exchanger is increasingly used to heat or to cool strongly viscoelastic or thixotropic resins and adhesives. In many cases, the static CSE-XR® is capable to replace kneaders or extruders. Operation and maintenance costs are negligible, thus pay-back is achieved in a very short time.

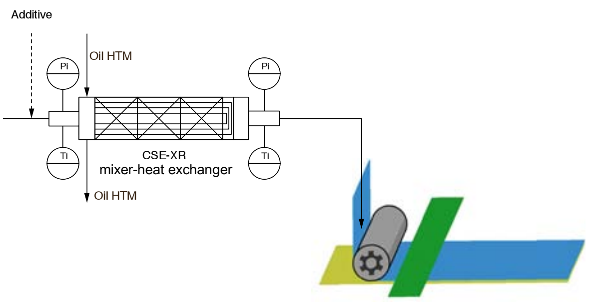

Fig. 3 Basic scheme of a coating plant

Filling Process of Adhesives

Resins and adhesives often have to be cooled and remixed after the production process, before being transferred to the filling section. Unwanted reactions of hot resins and adhesives are thereby inhibited and the evaporation of solvents and monomers is prevented. In addition the precipitation of particular ingredients is distinctively reduced and the product quality strongly improved.

The strongly increased viscosity of the cooled product makes high demands on the exact design and dimension of the cooling unit. It is a well known fact, that after a certain time almost all types of static coolers fail, due to plugging. Multi-tube heat exchangers often have completely clogged tubes and thereby not only a weak performance, but also an unacceptable temperature profile in the melt. In the CSE-XR® mixer-heat exchanger, however, the uniformly distributed shear forces in combination with the unrivalled radial mixing efficiency inhibit plugging and fouling very effectively.

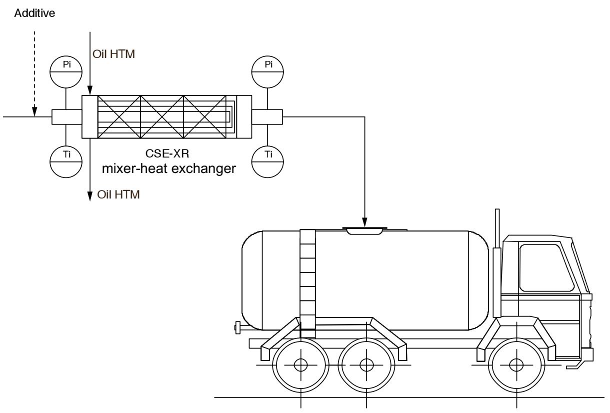

Fig. 4 Basic scheme of a filling plant

A constantly high cooling and mixing performance at a small working volume is guaranteed. The CSE-XR® mixer-heat exchanger increasingly replaces dynamic kneaders.

Extrusion

In extrusion processes, CSE-XR® mixer-heat exchangers are used to cool or heat in order to adjust the viscosity of the melt to its optimum in respect to the process conditions. A typical example is the optimisation of the cutting-ability of semi-crystalline and amorphous polymers in granulation units. The CSE-XR® mixer-heat exchanger ensures the heat transport and plug-flow at minimized working space. Hot spots are efficiently eliminated and the gentle shear forces prevent any decomposition of the polymer induced by mechanical stress, thus leading to the best possible quality of the product.

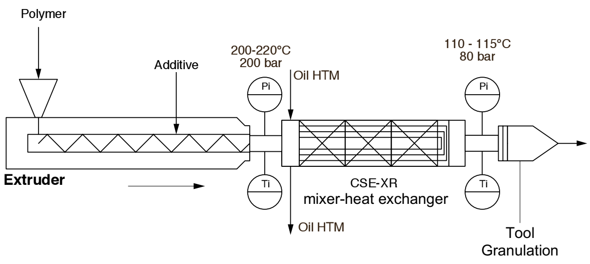

Fig. 5 Basic Scheme of the XPS-extrusion process

Extrusion of Foam

For the production of PP-E-particle foam (also valid for polyethylene, polystyrene, PET or biopolymers), granules of polypropylene are melted in an extruder and the blowing agent (such as pentane or CO_2) is mixed-in under high pressure. The mixture is pressed through a nozzle, causing the polymer to volume expansion by a factor of 20 to 50. The obtained strings of foam are cuted by rotating blades in the water-ring-granulator or in the underwater-granulation to particles of 2 to 8 mm diameter. These particles are separated from the water, dried, collected and conditioned in silos before they will be further processed to the definitely shaped foam-pieces.

If producing fine-porous XPS (extruded polystyrene hard foam), the CSE-XR® mixer-heat exchangers are replacing dynamic cooling extruders or they are supporting those, if the capacity of a plant is increased.

A homogeneous and controlled cooling process must be ensured if producing foams, since the risk of maldistribution caused by increasing viscosities is high. The use of multi-tube heat exchangers can be problematic, since particular tubes can clog completely.

Due to its special design, the CSE-XR® mixer-heat exchanger is capable to cope with high differences of viscosities (inlet to outlet or even in the melt itself) without any problems. The polymer is thereby mixed at low mechanical stress. The device has an excellent self-cleaning ability and allows quick changes of the polymer to be processed.