

INJECT AC: Metering system for feeding liquids under pressure

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Oerlikon Barmag is an established mechanical engineering company in the manmade fiber industry and can look back over decades of development and construction of highly productive and innovative spinning lines and texturing machines. In addition to spinning and texturing systems, the core competencies include the manufacture of components for manmade fiber production such as extruders, winders, pumps and godets. Oerlikon Barmag consistently extended its product range to polycondensation systems and components for chemical and industrial applications.

1. Overview

Manufacturing products from polymer melts (e.g. spun textile manmade fibers) frequently requires low-viscosity additives to be added to the melt under high pressure. Adding these additives must be carried out with the utmost precision, as even the smallest deviations can change the product quality. For this reason, only metering systems can be used that operate with total accuracy even at high pressures and low viscosities. Many types of pumps – such as hose pumps, diaphragm pumps and frequently also single gear pumps – must be ruled out from the outset. Although other types of pumps – including high-pressure piston pumps – can deal with the high pressures, their feed is not uniform but pulsating.

It is for these very reasons that the “INJECT AC” was developed. This system meters low viscosity media under pressure with an accuracy of 100%, without the occurrence of feed flow pulsations.

2. Sample applications

2.1. Feeding spinning plant systems with extruders

In spinning plant systems, additives – such as UV stabilizers, flame retardants, liquid dyes, etc. – frequently have to be metered into the melt (e.g. PETP). This is possible by adding the liquid without pressure to the extruder’s hopper (additive 1). However, this can worsen the extruder’s feeding behavior. For this reason, the additives are frequently added under pressure downstream to the extruder screw.

The INJECT AC system is the ideal solution for feeding in this zone. The first pressure feed method is adding the product directly to the extruder between the extruder screw and mixer (additive 2). However, the prerequisite is that the extruder is equipped with a mixer capable of mixing in the additive with sufficient efficiency. The second option is to feed the product to separately driven dynamic mixers directly installed in the melt pipe.

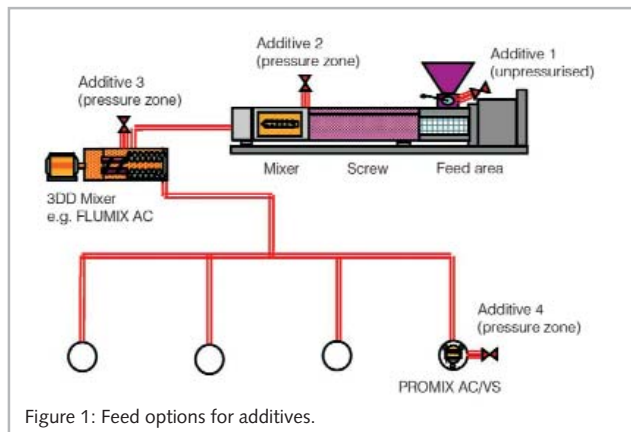


Figure 1: Feed options for additives.

The mixers are available for all relevant throughputs (FLUMIX AC up to approx. 200 kg/h). The third variant for adding the additive to the melt is to feed it directly into a spinning pump with an integrated dynamic mixer (PROMIX AC or PROMIX VS pump). This option provides maximum flexibility as it offers the possibility of injecting a different additive for each spinning position.



Figure 2: INJECT AC (compact type).

2.2 Feeding into cellulose spinning systems

When manufacturing certain cellulose fibers, a low-viscosity additive-suspension is added to the high-viscosity spinning solution. To this end, metering the suspension must be carried out under pressure and at a temperature. And the INJECT AC system is also the perfect solution for ensuring absolutely precise feeding of the suspension. The heating of the metering unit is carried out using a liquid heat carrier medium, which is simultaneously used for heating other components within the cellulose spinning system.

2.3 Feeding PIB

In certain film systems, the melt for manufacturing particularly elastic products, polyisobutene (PIB) has to be added under pressure in a precisely defined quantity. To be able to remove PIB from the tank and then convey it, it has to be heated to approx. 100°C, which considerably reduces the viscosity. The electrically-heated version of the INJECT AC system is the perfect solution for this application.

3. Specifications and operating data for the INJECT AC metering system as compact type

INJECT AC systems are autonomous “Plug and Play” units that comprise a metering unit and a control box. All electrical connections between the control box and the metering unit are plug-gable, so that the initial installation, as well as subsequent re-installations, can be carried out with the minimum of effort.

The INJECT AC metering units as compact type fundamentally comprise the following components:

- ❖ Booster and metering pumps.
- ❖ Two geared motors with digital speed measuring and integrated frequency inverter.
- ❖ Two pressure sensors for measuring the pressures upstream and downstream to the metering pump.
- ❖ Pump block for mounting the pumps and connecting the liquid pipes.

The following optional components are available for metering heated media:

- ❖ Pipework for heating using liquid heat carrier.
- ❖ Electrical heating.
- ❖ Heat-insulation for all product-conveying components.
- ❖ Special pressure sensors for temperatures in excess of 100°C.

The control box has the following main features:

- ❖ All electrical connections to the metering unit are pluggable.
- ❖ All settings are carried out using a touch screen.
- ❖ All important parameters are displayed on the touch screen.
- ❖ All important control and adjustment functions are included.
- ❖ The control unit can be connected to the customer's overall system via a Profi bus interface.
- ❖ Optionally, the control box can be equipped with controllers for several heat zones (for the metering unit, for heated hoses, etc.).

Operation data for the INJECT AC units:

- ❖ Maximum permissible feed pressure: 300 bar.
- ❖ Minimum viscosity: 100 mPas.
- ❖ Throughput range: 0.03 - 70 Liter/hour.
- ❖ Maximum operating temperature: 100°C (optionally up to 200°C).
- ❖ Deviating application data (e.g. viscosities smaller than 100 mPas) are possible depending on the application.

4. Function of the INJECT AC units

The heart of the INJECT AC metering unit is two precision gear pumps. These are mounted onto a joint pump block and hence connected in series. The first pump assumes the pressure build-up, while the second pump meters; for this, each pump is equipped with its own drive.

The speed of the second pump is determined by the conveyed feed volume, which can be set at the control box.

The speed of the first pump is set via a complex control algorithm so that the pressure between the two pumps is always exactly as high as the feed pressure ($p_1 = p_2$, $\Delta p = 0$ bar). Even in

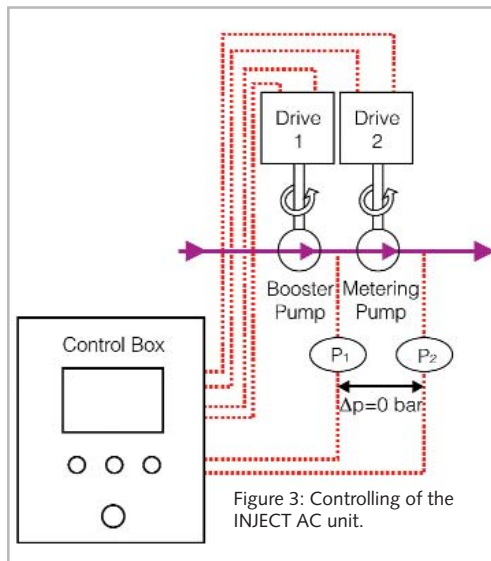


Figure 3: Controlling of the INJECT AC unit.

the event of fast pressure changes in the pipe downstream to the second pump (feed pressure), the pressure between the pumps follows without significant delay and without oscillations.

As a result of the above-described control, the second pump always operates with a differential pressure of 0 bar and hence meters with a volumetric efficiency of 100%. This means that there is an absolute proportionality between the prescribed speed of the metering pump and its throughput of additives.

The high level of precision with which the pumps meter and the use of speed-controlled motors enable an extremely high speed setting range of almost 1:100.

Hence, a very wide throughput spectrum can be covered with only one

pump size (e.g. 0.2 cc/revolution). It goes without saying that there is a large range of pump types with various throughput capacities (cc/revolution) available. These pumps all have the same hole pattern for bolt connections and are therefore exchangeable.

5. Summary

The INJECT AC metering system was developed to feed liquid low-viscosity additives under pressure. It is characterized by the following properties:

- ❖ 100% metering accuracy by using a booster pump and a metering pump.
- ❖ Feed pressures of up to 300 bar are possible.
- ❖ Viscosities from 100 mPas are possible. Additives with lower viscosities can also be processed depending on the application.
- ❖ Very large throughput spectrum of between 0.03 and 70 liters/hour.
- ❖ Heating by means of liquid heat carrier or using electrical heaters is possible.
- ❖ INJECT AC is supplied complete with control box as a "Plug and Play" system.
- ❖ All electrical connections between control box and metering unit are pluggable.
- ❖ Operation via a touch screen.
- ❖ The control system is equipped with a Profi bus interface. ♦

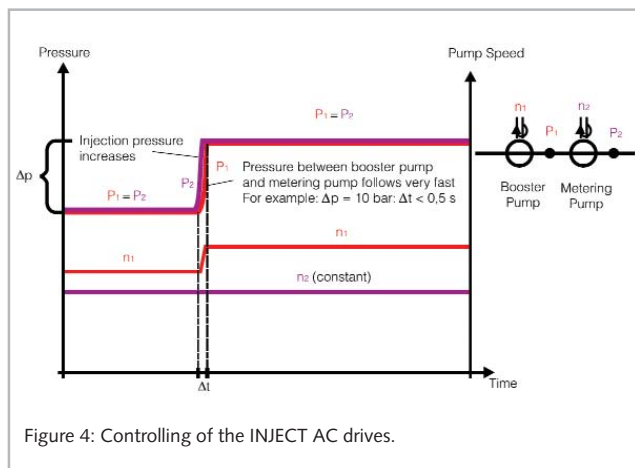


Figure 4: Controlling of the INJECT AC drives.

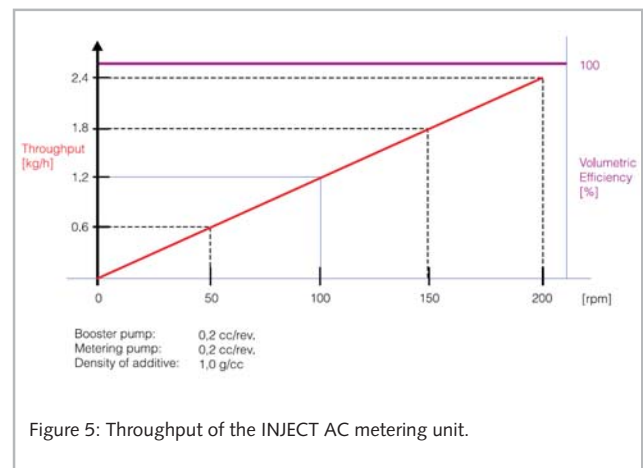


Figure 5: Throughput of the INJECT AC metering unit.