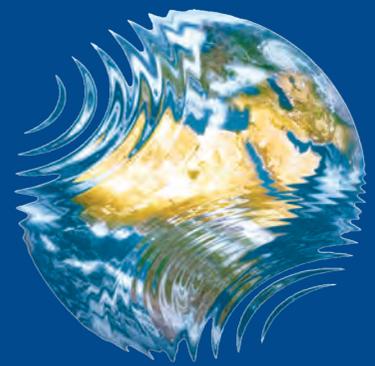


# FLOQUIP PSU

*High speed polymer  
dissolution equipment*



**SNF FLOERGER**

# FLOQUIP PSU™ : Polymer Slicing Unit

## High Speed Dissolution Equipment

The FLOQUIP PSU™ is a patented proprietary equipment designed for high speed dissolution of very high molecular weight polymer in water. Initially designed for the oil industry, the FLOQUIP PSU™ is recommended whenever time of dissolution and space for maturation are an issue in large volumes of use.

## Polymer Flooding: PF, SP and ASP

SNF, the world's larger producer of polyacrylamide (PAM), has developed a unique expertise targeted to polymer flooding applications, one of the most effective enhanced oil recovery techniques.

Polymer flooding consists in adding polyacrylamide to the injection water in order to increase the viscosity of the injected solution and to consequently improve the oil recovery factor. To ensure the maximum recovery efficiency, it is essential that the polymer solution be injected at the required viscosity level and be protected from further degradation once in the reservoir.

Polyacrylamide used in polymer flooding have high to very high molecular weight (typically higher than 15 million Daltons) and are quite sensitive to thermal, chemical and mechanical degradation. A great care should therefore be taken to design the polymer dissolution and injection system. To that end SNF has developed proprietary technology combining chemical and mechanical approaches. At the centre of this knowledge lies the polymer slicing unit (PSU). This technology has been patented worldwide.

Note: The molecular weight of the polymer is not affected by the slicing mechanism (see Screen Factor and Viscosity chapter on page 10)

FLOQUIP PSU 100 complete dissolution unit in a containerised skid



FLOQUIP PSU 100



View of the Powder Hopper and FLOQUIP PSU 100 assembly



## Advantages

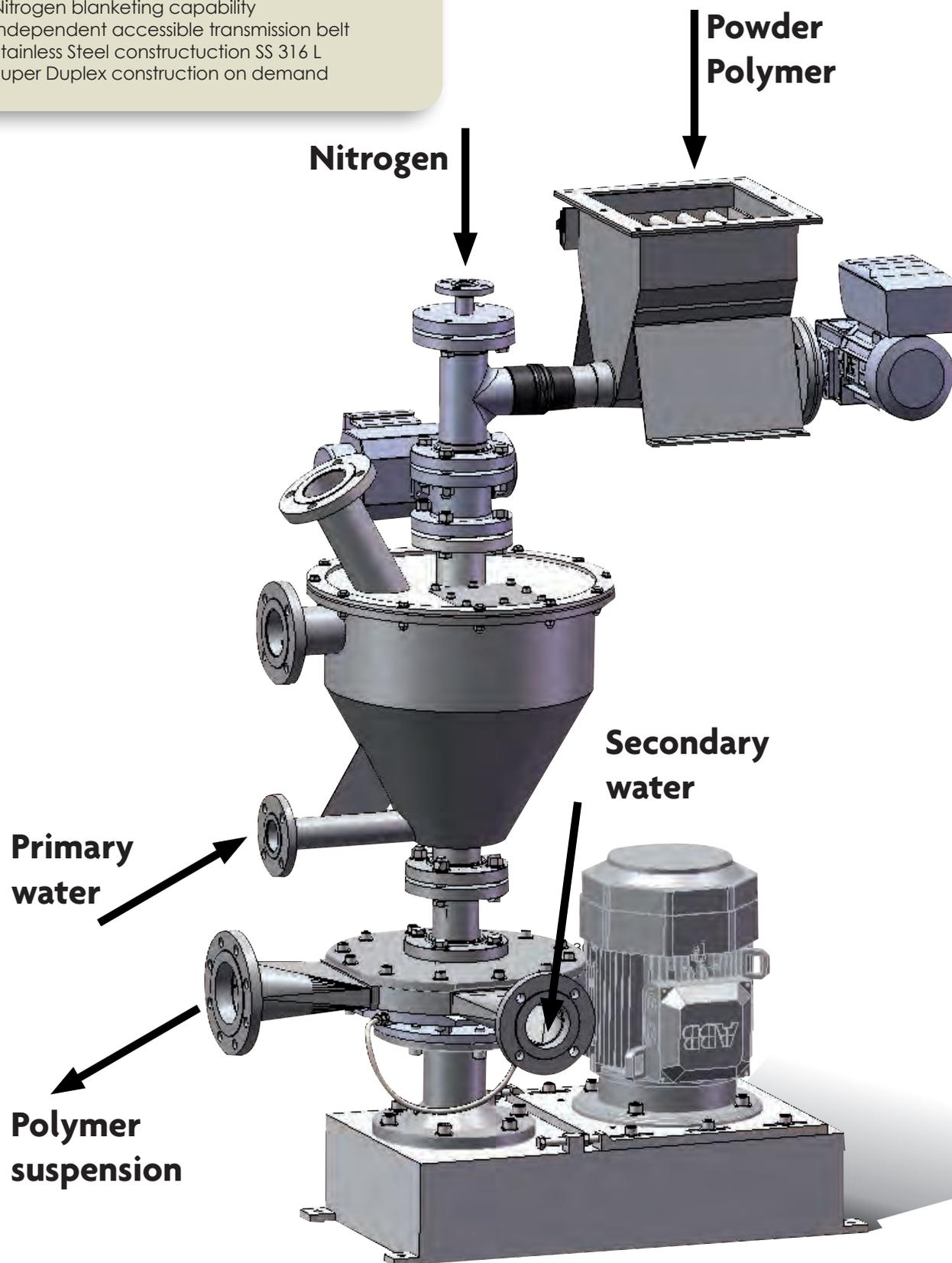
The FLOQUIP PSU™ is proprietary equipment designed for high speed dissolution of polymer in water, under inert atmosphere and without degradation of the molecular weight of the polymer.

The main advantages of the FLOQUIP PSU™ include:

- Decrease the dissolution time of the polymer by at least 2 to 4 times and increase the concentration of the polymer up to 20 g/l, with a consequential reduction of the dissolution tanks by a factor of at least 4 and the application pumps by a factor of at least 2.
- Low speed equipment in order to decrease the maintenance to a minimum.
- Elimination of any filtration stage of the polymer solution due to the avoidance of the formation of so-called "fish-eyes" even at very high concentration. It is indeed essential to ensure the appropriate injectivity level of the polymer solution in the reservoir.
- Accrued protection of the polymer solution against chemical degradation by oxygen during the dissolution stage. Oxidation-reduction reactions are indeed at the root of the chemical degradation of polymers and it is essential to strictly control the amount of dissolved oxygen in water. This is achieved through nitrogen blanketing.

## Features

Specifically designed for water soluble polymers  
High Polymer Concentration 10-15-20 g/l  
Nitrogen blanketing capability  
Independent accessible transmission belt  
Stainless Steel construction SS 316 L  
Super Duplex construction on demand



## Features

FLOQUIP PSU™ 300 ready to be shipped



### FLOQUIP PSU™ 100

#### Specifications

Size	
Length	1005 mm
Width	646 mm
Height	1350 mm
Weight	350 kg
Tension	400V-50Hz / 460V-60Hz
Power supply	4 kW
Max performances	
Max powder	125 kg/h
Max water flow	10 m <sup>3</sup> /h
Max nitrogen flow	5 Nm <sup>3</sup> /h
Max nitrogen pressure	50 mbar

### FLOQUIP PSU™ 300

#### Specifications

Size	
Length	1302 mm
Width	967 mm
Height	1901 mm
Weight	650 kg
Tension	400V-50Hz / 460V-60Hz
Power supply	18.5 kW
Max performances	
Max powder	350 kg/h
Max water flow	30 m <sup>3</sup> /h
Max nitrogen flow	10 Nm <sup>3</sup> /h
Max nitrogen pressure	50 mbar

### FLOQUIP PSU™ 600

#### Specifications

Size	
Length	1564 mm
Width	967 mm
Height	2248 mm
Weight	870 kg
Tension	400V-50Hz / 460V-60Hz
Power supply	37 kW
Max performances	
Max powder	700 kg/h
Max water flow	50 m <sup>3</sup> /h
Max nitrogen flow	10 Nm <sup>3</sup> /h
Max nitrogen pressure	50 mbar

## Performance

The FLOQUIP PSU™ can use polymers in powder form with a standard particle size that are therefore easy to handle as dust is not formed. The polymer is first pre-wetted under nitrogen atmosphere with a limited quantity of water/brine and the dispersion is nearly instantaneous and occurs before the so-called shearing step. Through its grinding pump, the FLOQUIP PSU™ then reduces the polymer particle size from about 1000 to less than 300 micron. The premixed polymer is lastly diluted with the residual quantity of water/brine necessary for its final dissolution. The resulting solution is then transferred (using or not a complementary booster pump) and sent to a maturation tank.

The time required for all of the above process steps until final dissolution will fluctuate based on water temperature/ characteristics and the type of polymer but will at least decrease by a factor of 2 to 4. The molecular weight of the polymer will be preserved and there will be no gel formation even at concentrations as high as 40 g/litre.

Conventional systems for dissolving high molecular weight dry polymers have a limitation around 5 g/litre in concentration due to the fact that the viscosity increase cannot be controlled long enough to allow for higher concentration. The FLOQUIP PSU™ can handle solution concentration of 10 to 15 g/litre and even 20 g/litre under specific conditions.

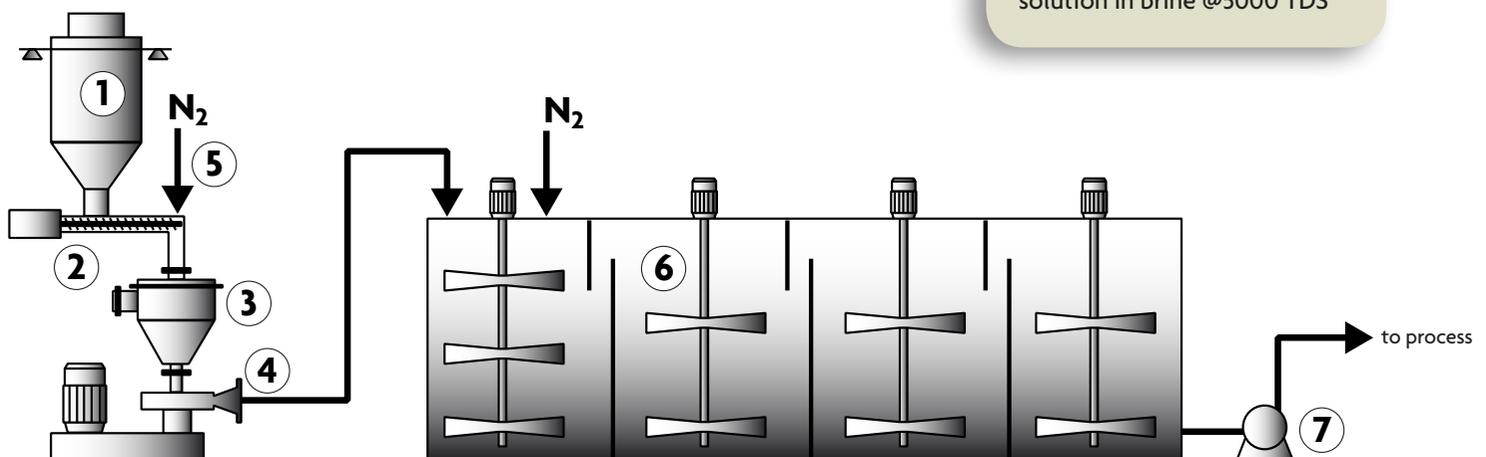
Overview of PDO's Marmul Polymer Plant in the Sultanate of Oman



A typical system using the FLOQUIP PSU™ will include a storage hopper (1) for the polymer in powder form, which has a screw feeder (2) on its base for transferring the polymer into a pre-wetting funnel (3) where the polymer is mixed with around 1/3 of the required quantity of water. This pre-wetting funnel has a slicing unit (4) at its base, where the polymer powder is incorporated to water by a rotor/stator device. The premixed polymer is then immediately put into contact with the remaining quantity of water for total dissolution. The pre-wetting stage is performed in an inert atmosphere by supplying nitrogen (5). Once the polymer has been pre-wetted, mixed and diluted, it is transferred to the maturation tanks (6) and finally pumped (7) to the process which, in EOR, are high pressure injection facilities.



PDO Marmul Oilfield  
5 FLOQUIP PSU 300 preparing  
a 10000 ppm FLOPAAM 3630 S  
solution in brine @5000 TDS

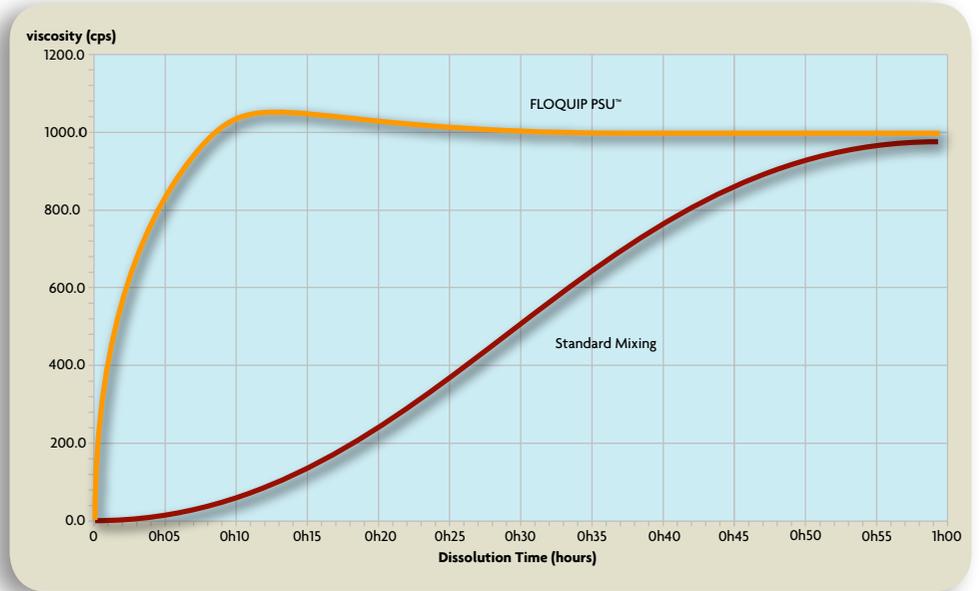


FLOQUIP PSU™ Schematic

# Size reduction

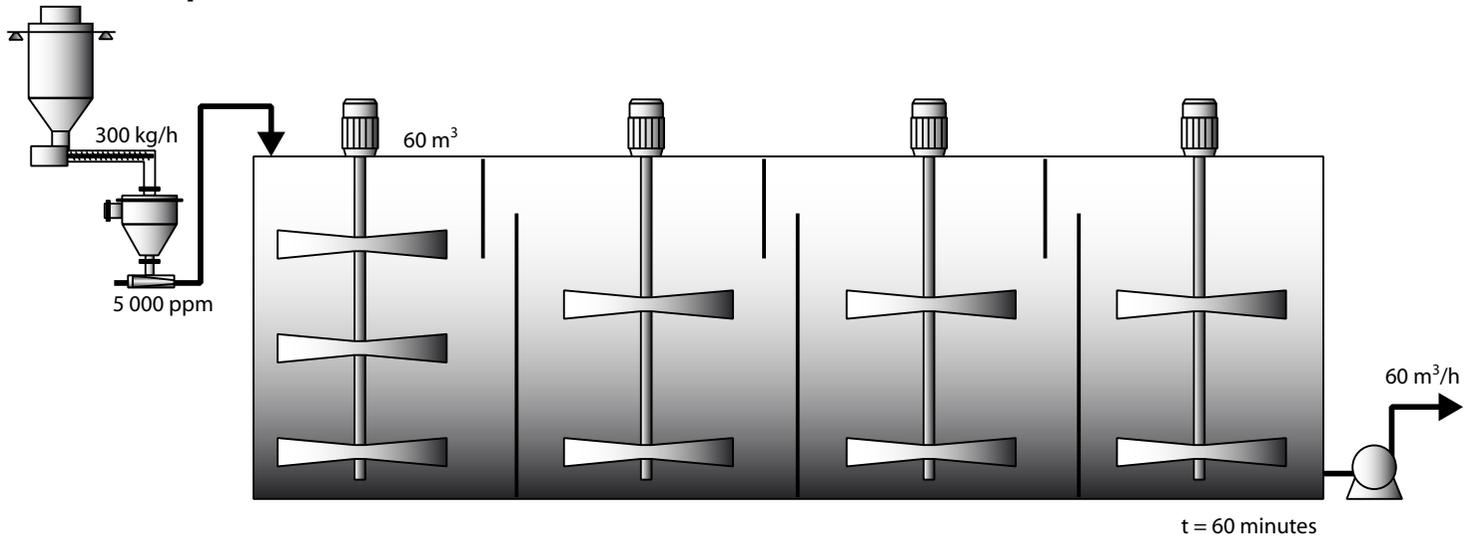
Traditional polymer dissolution units are pretty standard. A hopper contains the polymer powder, a screw feeder will bring a determined dosage to the wetting funnel, there are different types of wetting cones planes or jets, but whatever the system the maximum polymer concentration that can be achieved is 5000 ppm which induces relatively large installation footprints. An important reduction in equipment size and maturation time can be obtained by using the FLOQUIP PSU dissolution unit.

## Example for a 300 kg/h installation

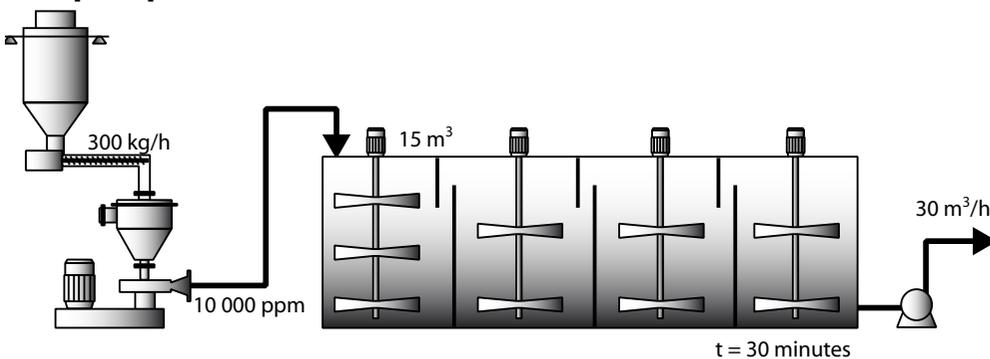


Graph 2 : Viscosity as a function of the shear rate for polymer prepared by standard mixing and PSU dissolution

## Traditional process with eductor



## Compact process with FLOQUIP PSU 300



Typical Equipment Size Reduction between an equivalent installation with or without FLOQUIP PSU

### Traditional Polymer Dissolution Unit

Considering a 60 minutes maturation time and a polymer concentration of 5000 ppm, the maturation tank is therefore 60 m<sup>3</sup> and the pump size to the process is 60 m<sup>3</sup>/h.

### FLOQUIP PSU 300 Dissolution Unit

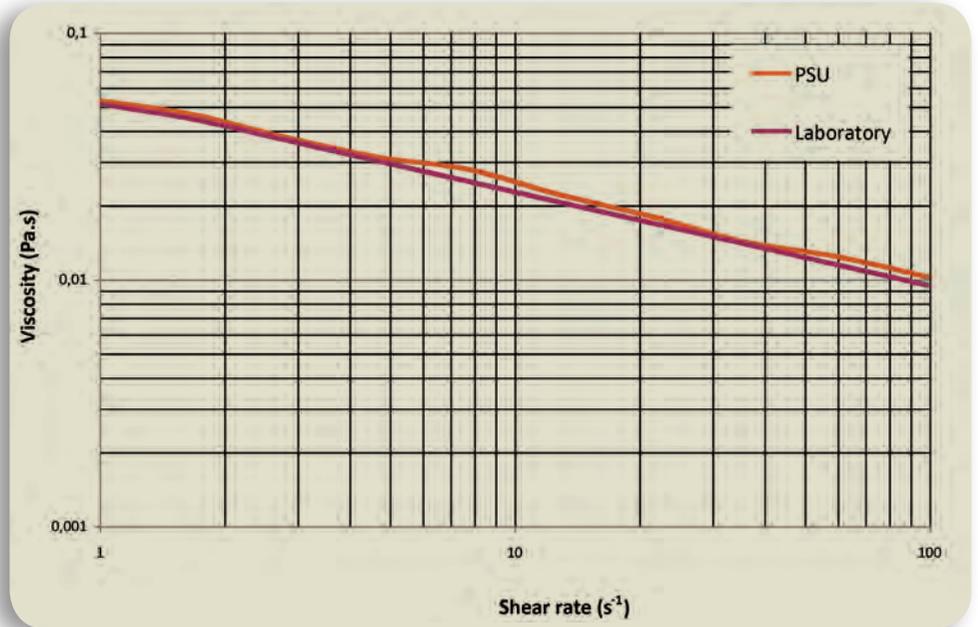
The polymer concentration that can be achieved is at least 10 000 ppm and the maturation time needed is maximum 30 minutes. Therefore the size of the maturation tank is only 15 m<sup>3</sup> and the pump to process is 30 m<sup>3</sup>/h.

# Screen factor and viscosity

The FLOQUIP PSU dissolution unit does not generate any degradation of the polymer's characteristics.

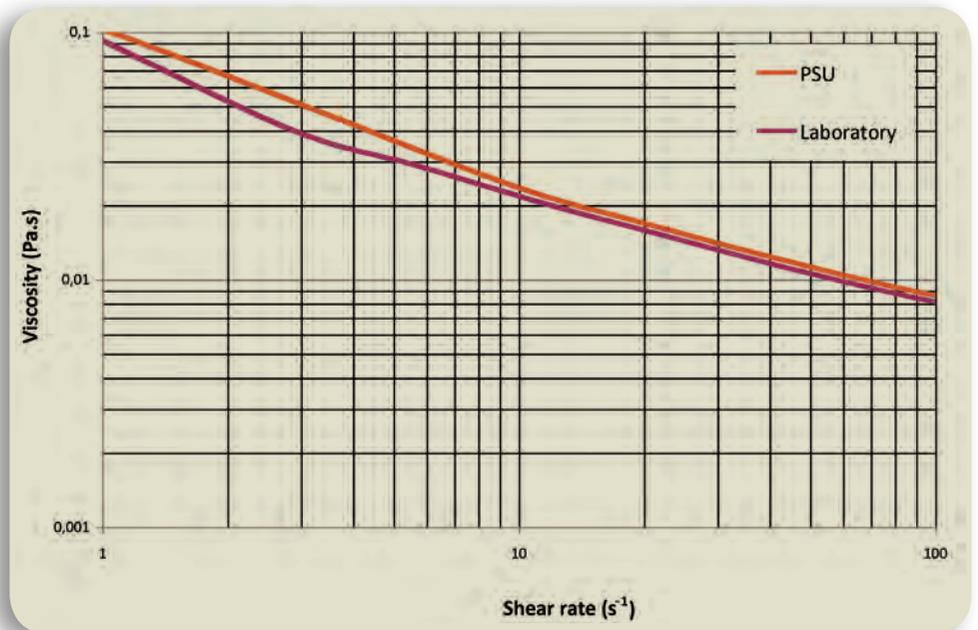
Screen factor and viscosity of solutions of polyacrylamides dissolved using FLOQUIP PSU are similar to the values obtained by laboratory preparation or traditional mixing units.

Screen Factor Testing Equipment



Viscosity of FLOPAAM FP 3630 S in a 5000 TDS Brine

A compact FLOQUIP PSU installed on an FPSO vessel



Viscosity of FLOPAAM FP 3630 S in Process Water

FLOQUIP PSU Dissolution Unit at a Canadian Tar Sands Site





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