Ahlstrom Pumps' Medium Consistency (MC®) Equipment IN Pulp Mill Applications

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MC® PUMP-THE KEY IN THE PUMPING AND TRANSFER OF MEDIUM CONSISTENCY (MC®) STOCK

Introduction

The centrifugal MC® Pumping opened entirely new possibilities for stock transfer and process development when it was for the first time successfully tested in mill scale in 1977 to 1978. The first commercial fluidizing centrifugal MC® Pump with degassing started in a bleaching plant application in 1980.

During the past ten years, MC® Pumping development has introduced the second generation pumping system products with larger capacity ranges, higher pump heads, higher pumping consistencies, lower energy consumption, and a wide range of different new or modernized MC® Pumping process applications.

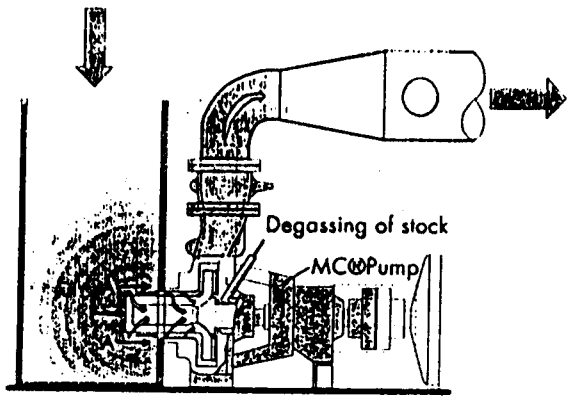

Fig2. MC® Pump arrangement for 8.18% consistency range.

The stock hence becomes fluidized and its flow characteristics resemble those of water. This way, the stock can be pumped reliably at a consistency of over 8% **(Fig.2)**, and even a

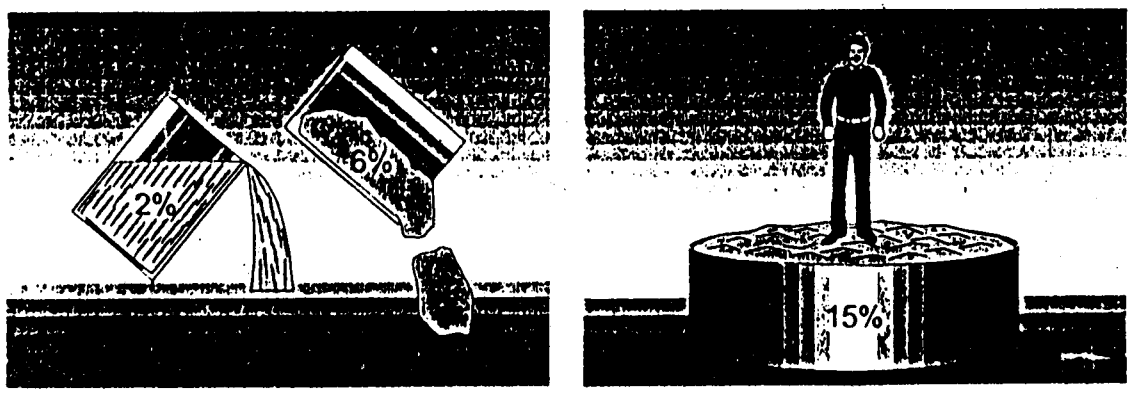

Fig 1. Effect of stock consistency on flow characteristics.

Fluidization, i.e. disintegrating the fiber network in the stock, is the solution in the pumping of medium consistency stock

Even at low consistencies, stock fibers establish a relatively stable fiber network **(Fig.1)**, which is disintegrated by the rotor of the pump as it rotates.

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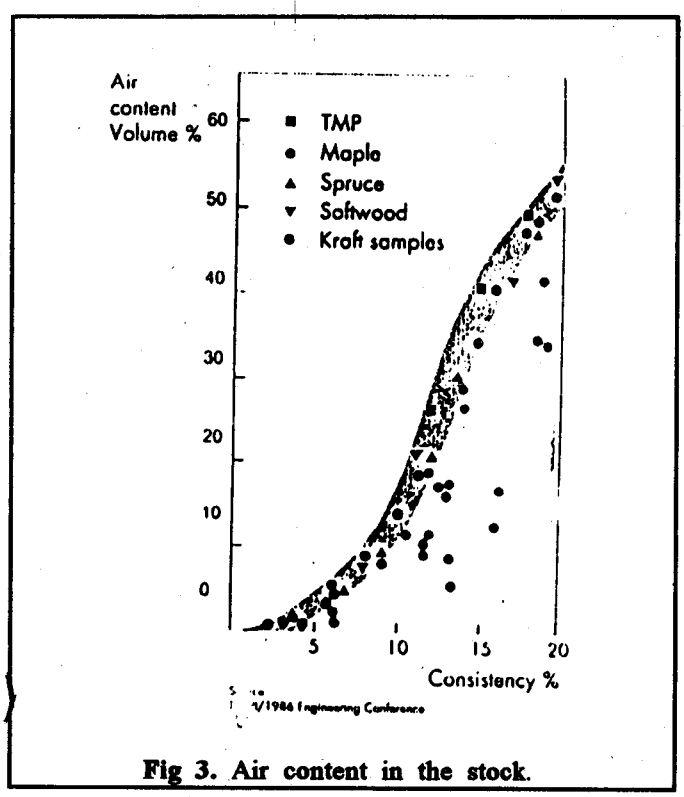

Fig 3. Air content in the stock.

consistency of 18% has been reached with the centrifugal pumping method.

Stocks often contain a large amount of air

The higher the stock consistency, the more it can contain air or gas **(Fig.3)** which disturbs not only pumping but also the reliable operation of the entire process. In the MC® Pump, this air or gas is separated and then removed by creating a certain pressure difference between the inlet side and the degassing chamber of the pump. This is achieved either by a sufficient inlet pressure or by means of a separate or built-in vacuum pump.

MCA and MCV Pumps as alternative designs

Ahlstrom manufactures two parallel MC® Pump series: MCA and MCV. These guarantee that the ideal pump is available for the prevailing pumping conditions, also giving optimum reliability and interchangeability with existing pumps.

The MCA Pump **(Fig.4)** is provided with a separate, external MDS Degassing System. The MCV Pump **(Fig.5)** features a built-in degassing system. Both types incorporate the same benefits of the Ahlstrom second generation centrifugal MC® Pumps.

The MCA/MCV Pump series covers capacity ranges up to 3000 ADMT/D and pump heads up to 170 meters. Stainless steel material alternatives for these pumps are austenitic cast steels like CG-8M or duplex steels like A-890 Grades 3A and 5A.

Titanium and 654SMO can also be selected as the materials for the wetted parts of the pump.

More than 1800 Ahlstrom MC® Pumps are operating worldwide.

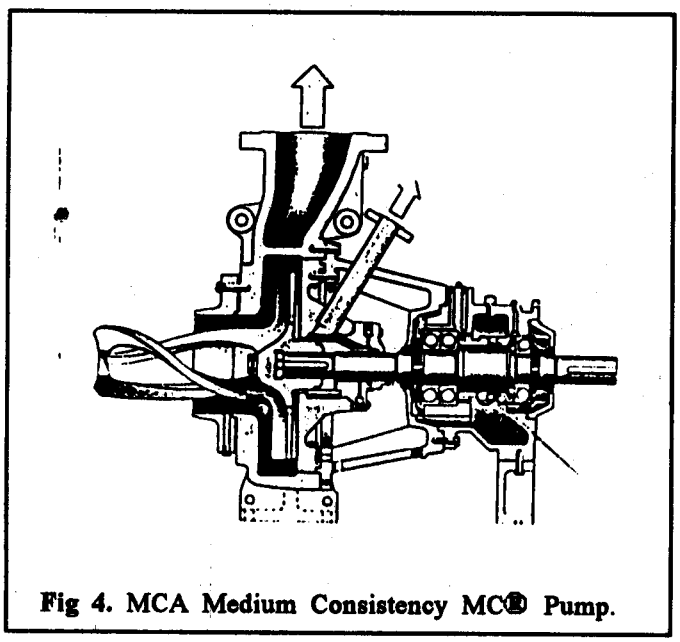

Fig 4. MCA Medium Consistency MC® Pump.

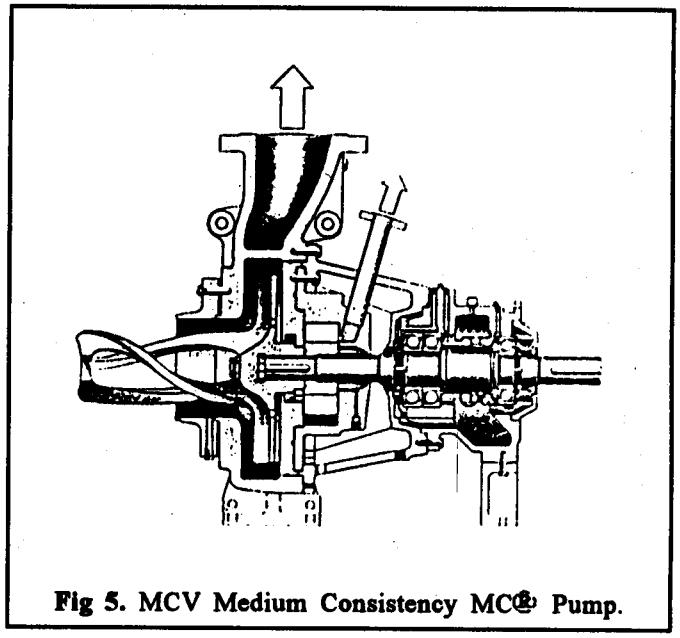

Fig 5. MCV Medium Consistency MC® Pump.

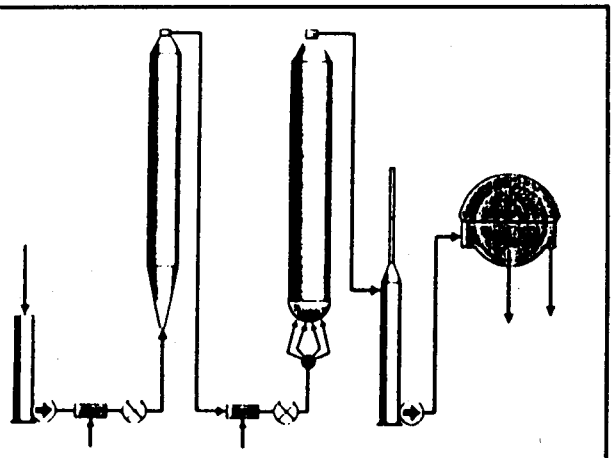

Fig 6. Pumping systems in a pressurized bleaching stage

MC Pumping applications

Pumping from a washer or from a blow tank

The most common application of MC® Pumping is to pump stock from washers and thickeners or after a bleaching reactor **(Fig.6)**. The stock falls into the MDL Dropleg or into the blow tank and is then transferred to the subsequent process stage by the MCA/MCV Pump.

The MC® Pumping system consists of the following key components: MDI. Dropleg or a blow tank as a pumping vessel, MCA Pump and MDS Degassing System, or alternatively MDI. Dropleg and MCV Pump with built-in degassing system **(Fig.7)**.

MC® Pumping is controlled so that all the stock falling into the Dropleg can be pumped further at the highest possible consistency **(Fig.8)**; a

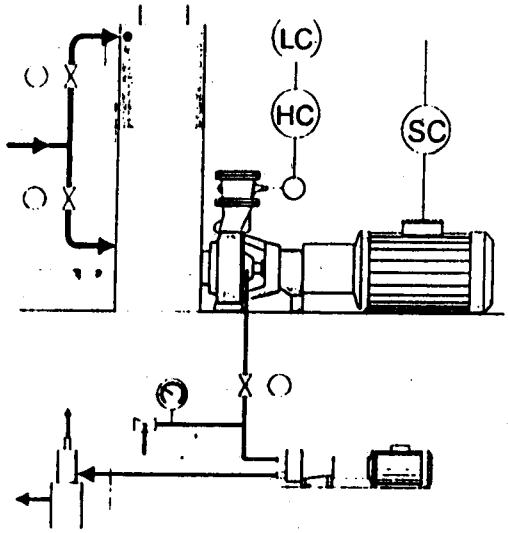

Fig 8. Control system in MC® Dropleg installation.

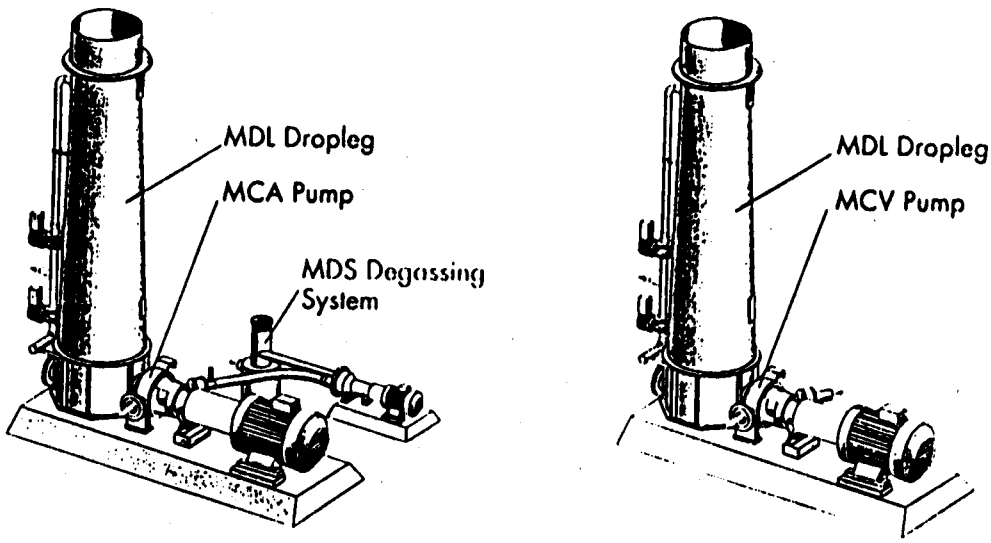

Fig 7. Pumping system components in Dropleg Pumping System.

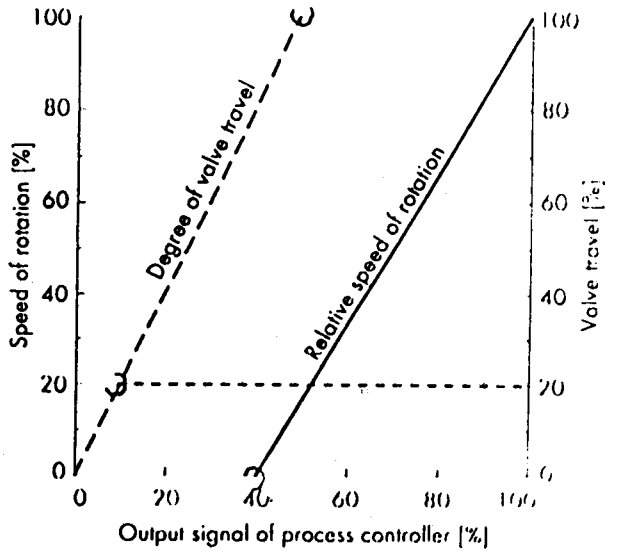

Fig 9. Combined valve and speed control system.

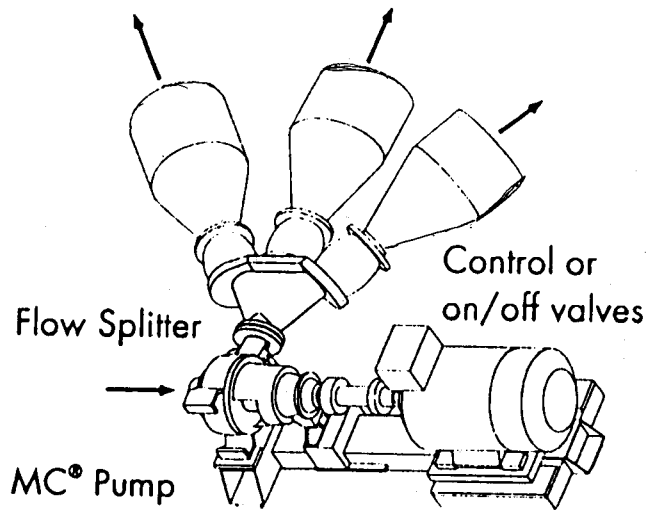

Fig 10. MC® Flow Splitter installation.

pumping consistency of 18% has been reached as a continuous process condition in a mill scale peroxide bleaching stage. The pulp level in the MDL Dropleg is measured by means of a gamma ray, capacitive measurement or pressure transmitter. The flow rate through the pump can be adjusted, depending on the circumstances, by means of a control valve, by changing the speed of the pump, or by applying a combination of these two methods **(Fig.9).** The level controller keeps the stock level in the Dropleg constant, not allowing the level to drop nor allowing the level to enter the previous equipment such as the washer; this provides stable operation in the process. The separate or built-in degassing system adapts itself to the respective volume of air contained in the stock and to the flow rate used. If great consistency variations occur in the incoming stock, resulting from factors such as consistency disturbance caused by the thickener or washer, the automatic water connections will stabilize pumping.

Flow splitting after discharge from the MC® Pump

The Flow Splitter is fixed directly to the discharge flange of the MC® Pump **(Fig.10).** The Flow splitter has a welded, specially- shaped sturdy construction, and the standard materials are SS2343 stainless steel, 254SMO or titanium depending on the process requirements.

This application is often used in pulp mill processes when creating an option to bypass a bleaching stage and when one pump is feeding two washers **(Fig.11)** or two or three storage towers. This parallel pipeline idea is typically advisable from the point of view of layout and costs, if the washers or towers are not located far from the pumping system.

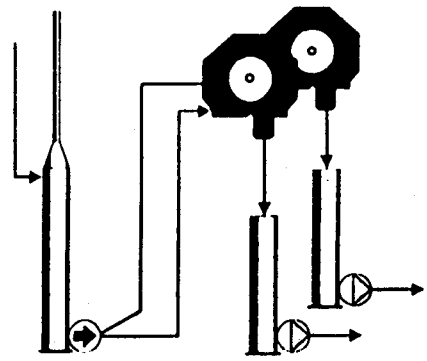

Fig 11. MC® Flow Splitter process application.

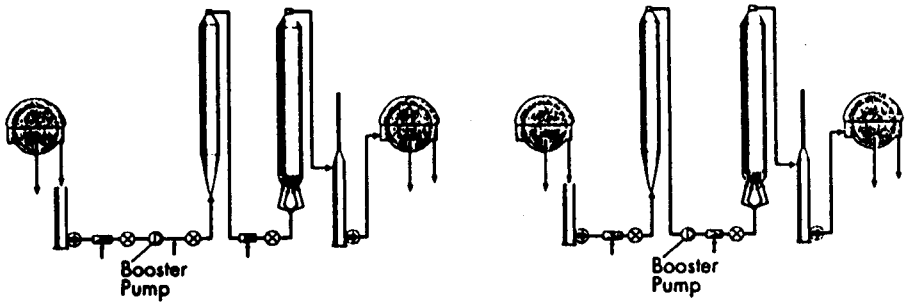

Fig 12. MC® Booster Pumps to feed pressurized bleaching reactors.

Booster pumping to feed pressurized bleaching reactors

In the modern pressurized bleaching stages (oxygen delignification and PO stages), it is necessary to create very high pulp line pressures with the MC® Pump feeding the stage so that the required process pressures can be achieved in the reactors. In these process applications, steam is fed and mixed into the pulp suspension to reach the process temperature, and chemicals such as oxygen are also fed and mixed into the pulp in the pressurized pipeline.

It is possible that the head requirement of the MC® Pump results in so high pulp line pressures that the available steam or oxygen pressures are not high enough to enable steam/oxygen feed and control. In these cases it is necessary to find a way to reduce the pulp line pressure in locations where steam and chemicals are fed. The solution is to install another MC® Pump, a booster pump, to the line and thus divide the head generation between two MC® Pumps. The advisable location of the booster MC® Pump depends on the detailed process data and on the mill arrangements **(Fig12).**

Tower discharge pumping

The discharge of large high consistency towers often involves difficulties, especially when a well-controlled pulp flow to bleaching or to the washer is required **(Fig13).** The MC® Tower Discharge Pumping System consists of the following key components: Discharge Scraper, MTB feed chute, tower isolation valve, MCA Pump and MDS Degassing System **(Fig.14).**

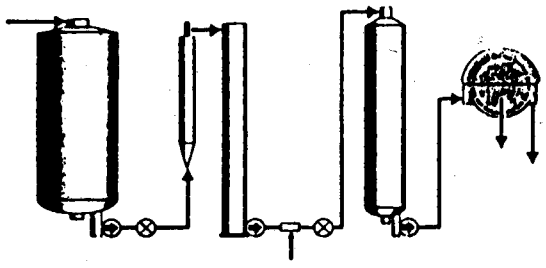

Fig.13. Typical tower discharge MC® Pumping systems.

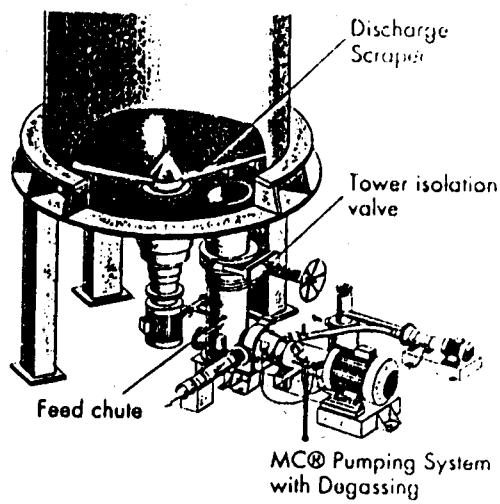

Fig 14. Pumping system components in a Tower Discharge Pumping System.

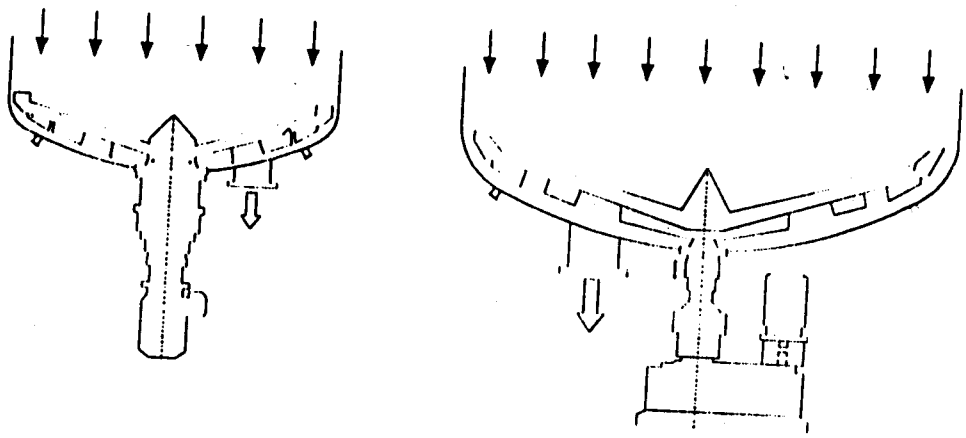

Fig 15. MC® Discharge Scraper constructions.

The Discharge Scraper manufactured by ahlstrom operates in connection with a medium consistency tower discharge pump. The Scraper scrapes the stock over the complete bottom area of the tower and leads it into the feeding chute of the MCA Pump, thus enabling an even discharge and simultaneously preventing channeling of the stock in the tower.

The Discharge Scraper also stabilizes the pumping procedure. The Discharge Scraper is available with or without a possibility for dilution. The diluting scraper simultaneously dilutes the stock uniformly and discharges the tower without interference. When using diluting scrapers, the consistency of the stock in the tower can be high (20 to 25%), and the pumping consistency is then within the MC range.

MC® Discharge Scrapers are manufactured in different sizes up to a diameter of 6500 mm. Each scraper size is available with or without the possibility for dilution.

The smallest sizes with a planetary gear are suspended from the tower bottom while the bigger sizes are provided with a spur gear which is fixed to the floor under the tower **(Fig.15).** These constructions do not require any separate additional bearing units.

The MC® Discharge Scraper material alternatives are SS2343 stainless steel or 254SMO.

The MC® Tower Discharge Pumping System can have different control strategies:

- The flow controller (FC) controls the flow rate of the MC® Pump by the valve **(Fig.16),** variable speed of the pump, or by a combination of these methods.
- The level controller keeps the level in the tower constant by using the above valve and/or pump speed for control or,
- Flow control and level control are used at the same so that the flow rate is kept constant and the flow rate set point is changed only if the level in the tower tends to change beyond the level set points.

Gas/air is removed by having a degassing system in combination with the MC® Pump (Fig.16).

Pulp can be diluted to the process consistency with the tower bottom water connections, with a diluting Discharge Scraper, and also in the MTB feed chute **(Fig.16).**

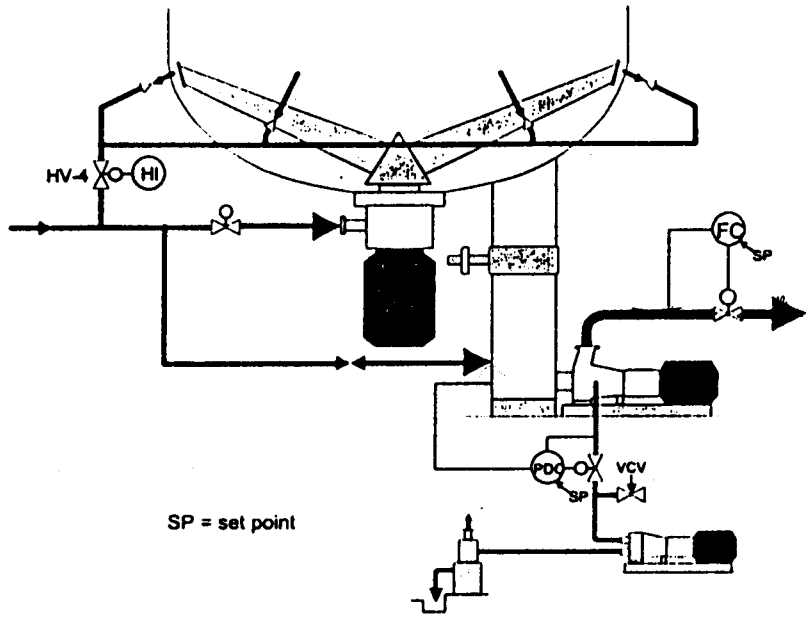

Fig 16. Control system in MC® Tower Discharge installation.

Booster pumping in long distance stock transfer applications

In an integrated pulp and paper mill, the distance between the pulp mill and the paper mill is often in the range of 300 to 400 meters. Stock is generally pumped in a diluted form, but an MC® Pump enables pumping at a consistency of for example 10 to 12%.

Medium consistency stock enters the dropleg of the MC® Pump e.g. from the filter. The MC® Pump, which is provided with degassing and rotates at a fixed or variable speed, pumps the stock to a booster pump of the same size where no degassing is required **(Fig.17).**

The booster pump which is provided with variable speed control pumps the stock to a storage tower **(Fig.18).**

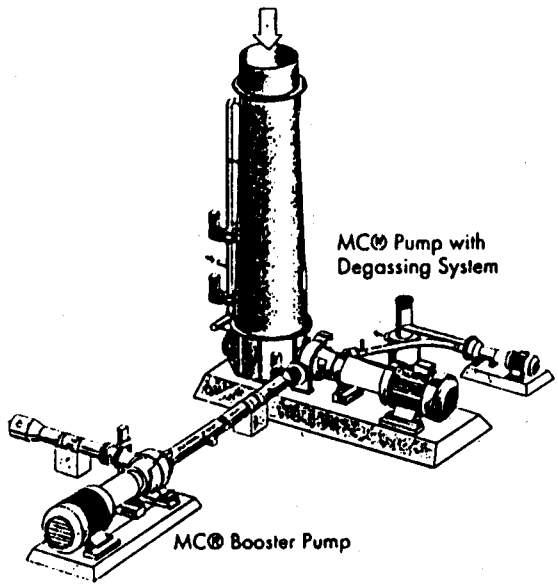

Fig 17. MC® Booster Pumping system.

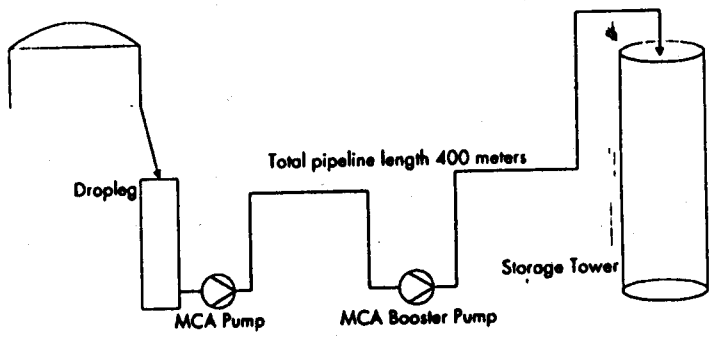

Fig 18. MC® Booster Pumping process application.

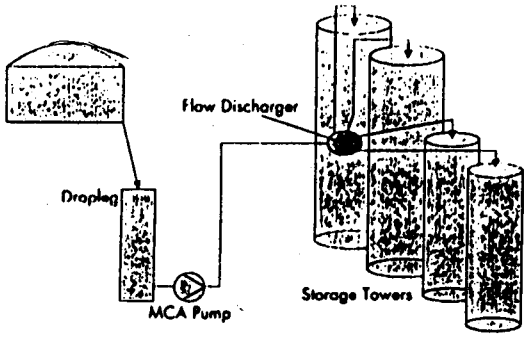

Fig 19. MC® Flow Discharger in storage tower application.

Pumping and controlled flow splitting to storage towers with an MC® Pump and a Flow Discharger

It is often necessary to transfer bleached pulp from the pulp mill to several storage towers which are all located relatively far (50 to 400 meters) from the bleached pulp washer and thus also far from the corresponding MC® Pump (Fig.19). This application is carried out so that there is only one discharge pipeline from the MC® Pump to the area of storage towers, and the flow is then divided at the end of the pipeline to several flows directed to the towers.

A plug flow is generated in the pipe when pumping medium consistency (8 to 16%) stock, and the fiber network holds the plug together. Dividing this kind of flow to precisely controlled partial flows at the end of a pipeline is not possible with a valve only; an MC® Flow Discharger is used in this application to fluidize the pulp and to divide and control the partial flows to the towers **(Fig.19).**

The MC® Flow Discharger operates so that the stock entering the chamber of the Discharger is fluidized by a rotor, and the outlet connections are constructed directly to this same chamber. Depending on the application, up to four outlet connections are available in one Flow Discharger, all connections with control or on/off valves (Fig.20). The Flow discharger itself does not generate pressure, so an MC® Pump is required in the process to pump the stock through the Discharger. The design of the MC® Flow Discharger is shown in **Fig.20.**

The Flow Discharger can be installed either vertically (Fig.20), horizontally **(Fig.21)** or in any other desired position depending on the application.

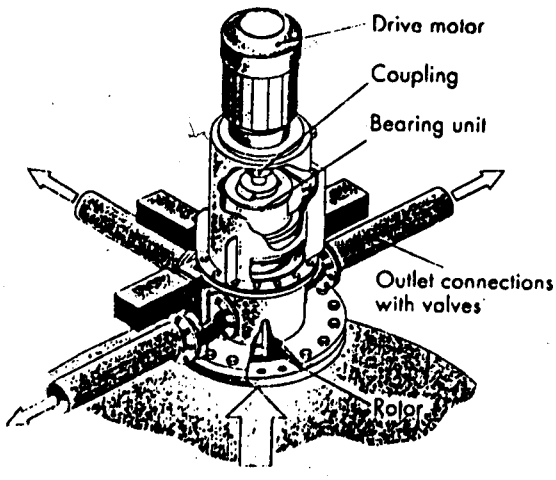

Fig 20. MC® Flow Discharger design and vertical installation

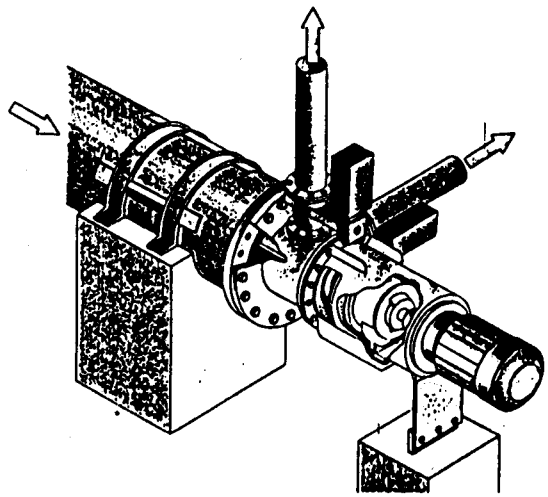

Fig 21. MC® Flow Discharger horizontal installation.

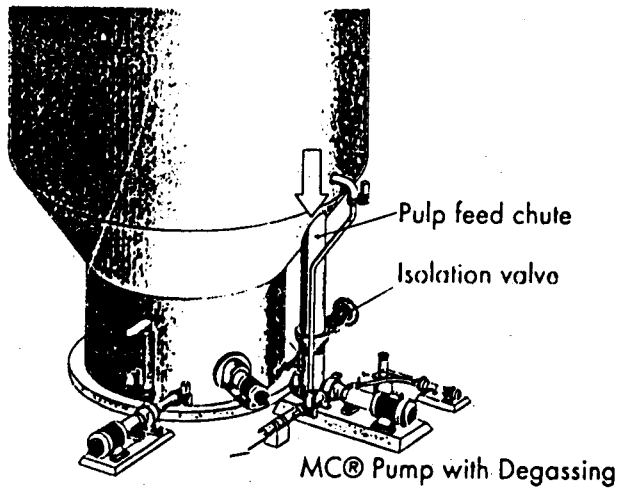

Fig 22. MC® Parallel Pumping System arrangement.

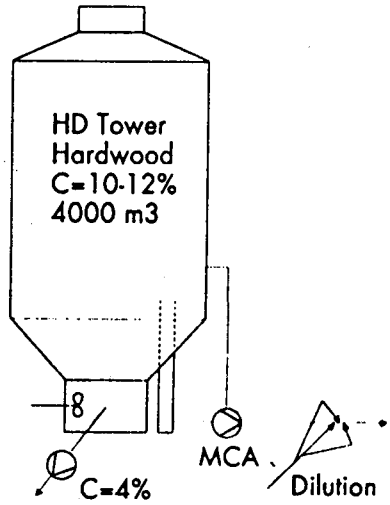

Fig 23. MC® Parallel Pumping System process application.

The Flow Discharger sizes cover capacity ranges up to 3000 ADMT/D, and SS2343 stainless steel, 254SMO or titanium can be selected as the material for the wetted parts.

Ahlstrom has delivered altogether more than 100 Flow Dischargers for different applications.

Parallel pumping of stock from the conical section of a storage tower

This application enables the simultaneous pumping of stock from two locations in the storage tower. From the conical section of the tower, the stock is transferred into the feeding chute and pumped by the MCA Pump at medium consistency to the following stage in the process. At the same time, stock is being diluted through the lower section of the storage tower and pumped further to the desired location at low consistency. White water from the paper machine can be individually used for diluting and e.g. two paper machines can be fed from one common storage tower. The pumping system arrangement is shown in **Fig.22** and a typical process application in **Fig.23.**

2. MIXING OF CHEMICALS AND STEAM

Introduction

Mixing chemicals and stock is one of the most important operations in stock bleaching. Good mixing provides homogenous bleaching conditions, reduces the consumption of chemicals and energy, improves product quality, and reduces the environmental load. Mixing is a key factor in the success of new bleaching sequences.

The stock is fluidized in the MC® Pump as the fiber network is disintegrated and also the gas is separated. This allows the efficient mixing of various liquid chemicals already in the pump. Most of these chemicals can be fed at a low pressure to the suction side of the pump.

All gaseous chemicals and steam are mixed with a separate AHLMIX™ Chemical Mixer. The chemical injection points are shown in **Fig.24.**

Each chemical and steam has its own features and special detailed selection and dimensioning guidelines which need to be followed when injecting the chemical to the pipeline.

Mixing of chemicals with the AHLMIX™ Chemical Mixer

AHLMIX™ is a medium consistency chemical mixer designed for mixing both gaseous and liquid bleaching chemicals into paper stock. The rotor of the mixer fluidizes the stock together with the casing turbulence generators, thus disrupting the fiber network and resulting in the optimum mixing result.

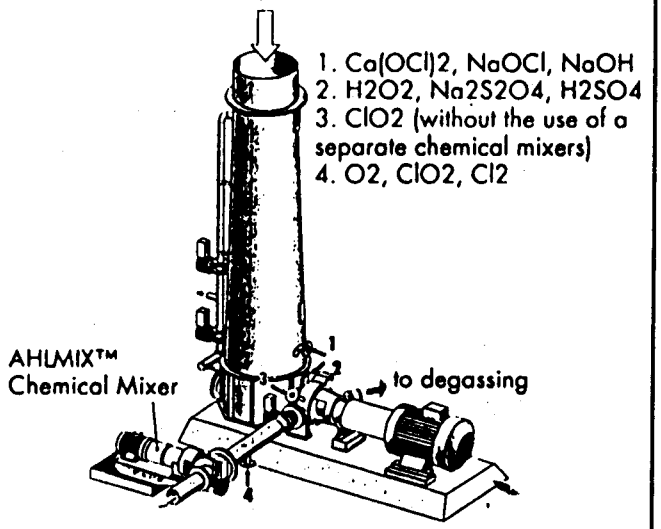

Fig 24. Chemical injection points in MC® Pumping and Mixing system.

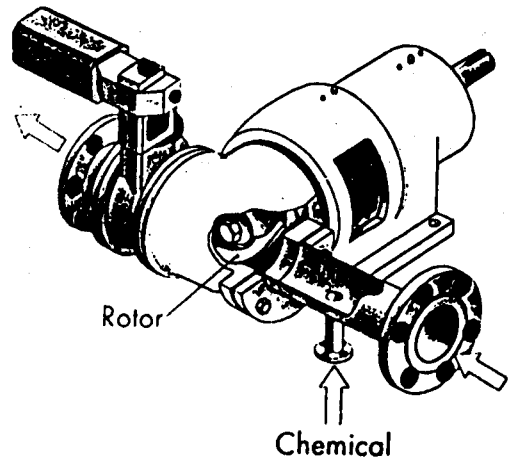

Fig 25. AHLMIX™ Chemical Mixer.

Perpendicular positioning of the rotor **(Fig.25)** and the unique three dimensional turbulence zone prevent the separation of gas. An inhomogeneity of 5 to 10% is normally considered acceptable; an AHLMIX™ Chemical Mixer reaches an inhomogeneity value of as low as 3 to 6%. The good mixing efficiency and the low power consumption are shown in **Fig.26.** **Fig.27** shows a comparison example of the installed power of different types of mixers in chemical mixing.

The design of AHLMIX™ is shown in **Fig.28.**

General AHLMIX™ design features are:

- Perpendicular rotor positioning
- Small pressure drop (0 to 4 meters)
- Small size of the Mixer and valves and thus small space requirement light weight and easy installation and maintenance
- Direct drives
- Stopped mixer passes stock flow

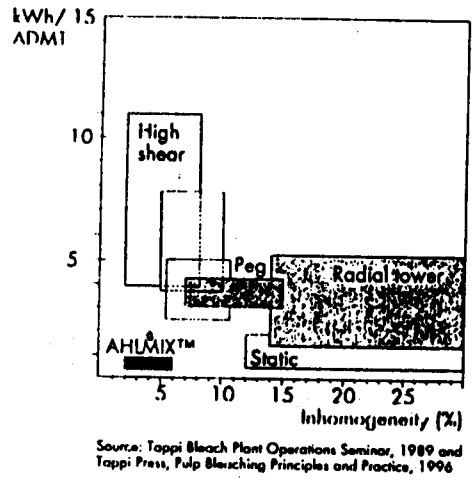

Fig 26. Mixing efficiency and energy consumption of different types of chemical mixers.

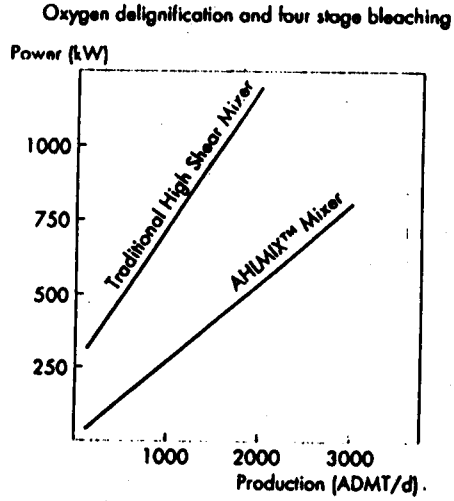

Fig 27. Installed power in typical pulp mill mixing applications.

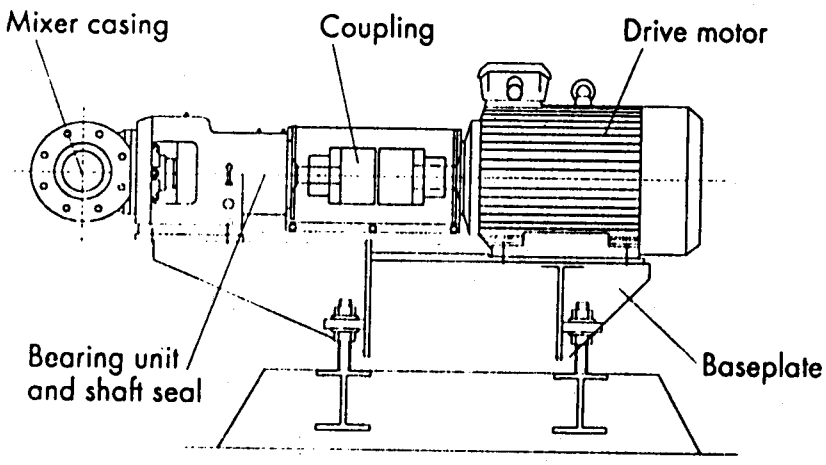

Fig 28. AHLMIX™ Chemical Mixer design.

The AHLMIX™ Chemical Mixer is used for a consistency range of 3 to 20 %, and the product sized cover capacity ranges up to 3000 ADMT/D.

AHLMIX™ is manufactured from stainless steel, titanium, Hastelloy or 654SMO depending on the chemical mixed and on the bleaching stage arrangement. Ahlstrom has delivered more than 400 AHLMIX™ Chemical Mixers.

Oxygen and steam mixing with the AHLMIX™ Chemical Mixer

In the oxygen delignification stages, oxygen and steam are introduced simultaneously into the steam injection pipe following the MC® Pump. No additional flow control or instrumentation is needed in the stock line. Oxygen can also be injected into the stock through a separate oxygen feeder.

In the AHLMIX™ Chemical Mixer, oxygen and steam are mixed efficiently into the stock **(Fig.29).**

A temperature increase of even more than 25°C has been reached by the AHLMIX™ Chemical Mixer.

Steam consumption is lower due to the closed and pressurized high consistency system. Disturbances and vibrations are eliminated by the correct dimensioning and piping arrangement and by even and smooth steam injection.

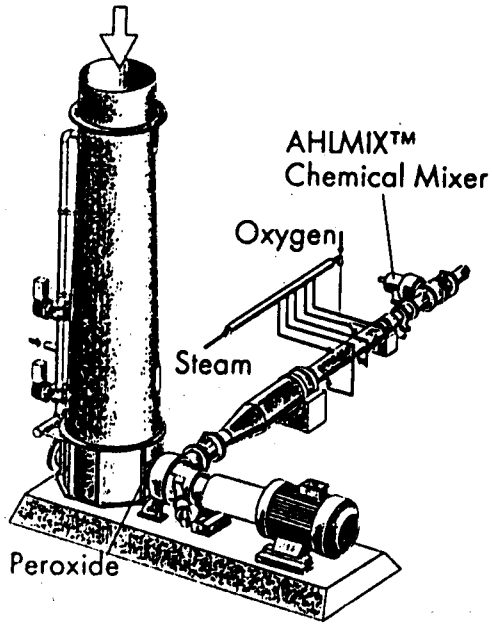

Fig 29. Oxygen, peroxide and steam mixing.

The optimum flow control and mixing result are achieved with the AHLMIX™ FS Mixer, with no pressure drop over the Mixer. Thus the power consumption of the mixing assembly is low, because no extra pump head needs to be generated to pass the stock through the mixer.

Peroxide and peracetic acid mixing

These chemicals are injected at a low feed pressure to the inlet side of the MC® Pump, to

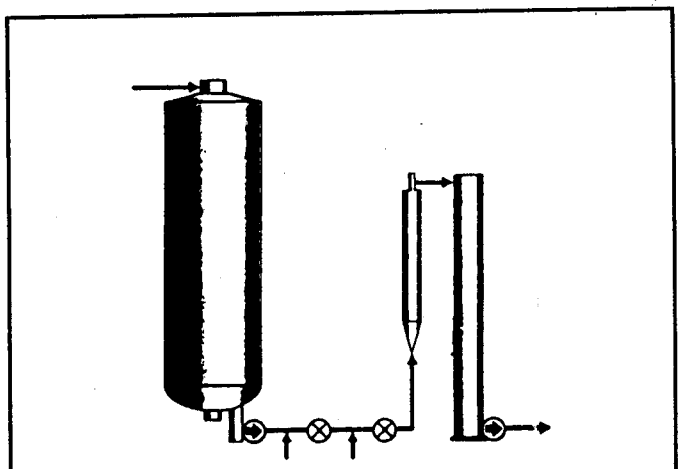

Fig 30. Ahlstrom ozone bleaching stage.

a location where air has already been removed from the stock. This way, the chemical reacts efficiently with stock and a good mixing results is achieved. In the PO and EOP stages, steam and oxygen are mixed with the AHLMIXTH Chemical mixer.

Chlorine dioxide and chlorine mixing

When mixing ClO_2 into the stock. a separate AHLMIX™ Chemical Mixer is recommended (Fig.24). In this case the MC® Pump in the stage in question is manufactured from stainless steel. If it is necessary to mix ClO_2 into the stock already in the MC® Pump, the pump needs to be made from titanium. This being the case, ClO_2 is introduced directly into the pump casing, to the high pressure zone. At the chlorination stage, when mixing both gas (Cl_2) and liquid (ClO_2), one or two AHLMIX™ Chemical Mixers are used. The compact AHLMIX™ Chemical Mixers can be installed in series, at intervals which create appropriate retention times.

Ozone mixing with the AMZ Chemical Mixer

The ozone containing gas is mixed into the stock in a fluidizing large volume AMZ Mixer. Typically two AMZ Mixers are installed in series in an ozone bleaching stage **(Fig.30).** The reactions between ozone and the fiber material are very fast; practically all reactions important from the point of view of delignification occur in the mixers. The AMZ Chemical Mixer has high shear sections that increase the contact area between the fiber flocs and the ozone gas. Gas separation is effectively prevented and mixing intensity is kept extremely high also with high gas volumes. Special attention has also been paid to minimizing the pressure losses in the AMZ Mixer as the gas volumes quickly increase if the pressure is reduced.

The design of the AMZ Mixer is shown in **Fig.31.**

The AMZ Mixer material alternatives are SS2343 stainless steel and 254SMO.

The biggest AMZ Mixers cover capacity ranges up to 2000 ADMT/D.

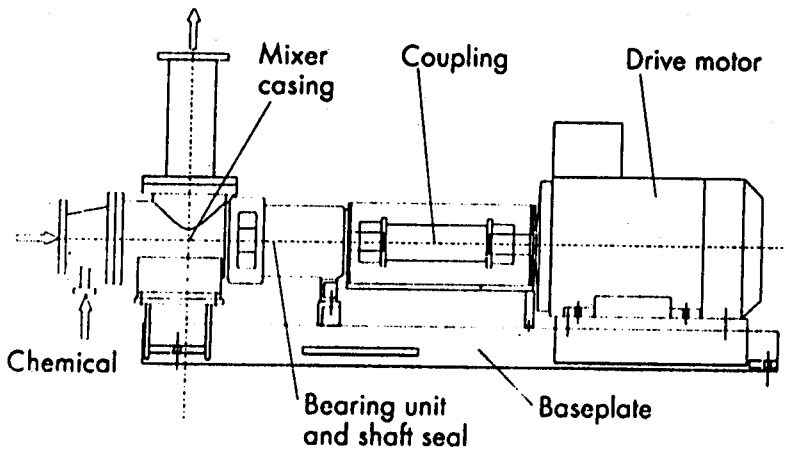

Fig 31. AMZ Ozone Mixer installation design.

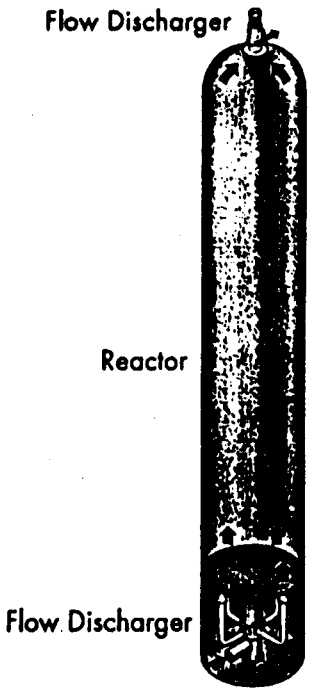

Fig 32. Pressurized bleaching reactor application with™ MC® Flow Dischargers.

FLOW DISCHARGER FOR EVEN STOCK FEEDING AND DISCHARGING OF A BLEACHING REACTOR WITHOUT ANY CHANNELING OF REACTOR FLOW

The distribution of stock into the bleaching reactor and discharging it from there with the Flow Discharger has been introduced in oxygen, peroxide and dioxide stages (Fig.20 and **Fig.32**). In reactor feed, the stock in fluidized and divided into equally large flows that are led to the reactor bottom. This Flow discharger arrangement provides mechanical advantages and the separation of gas at the reactor bottom is avoided.

The stock discharge from the reactor takes place with a corresponding Flow Discharger. The advantages of the Flow Discharger include compact size, excellent mechanical structure, easy maintenance, uniform pulsation free discharge, and a possibility to remove inert gas between reactors and before the blow tank. The MC® Flow Discharger is described in section 1.5.6.

RESEARCH AND DEVELOPMENT

Research and development receive top priority at Ahlstrom Pumps Corporation. As a result, Ahlstrom has today more than 30 patented inventions and a growing number of pending applications relating to MC® Pumping, transfer and mixing. At the full scale R&D Center, the equipment is tested under process conditions. Ahlstrom's experience and commitment to the pulp and paper industry have made it a leader in stock pumping, transfer and mixing technology.

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