New development in shoe press technology

슈-프레스 기술의 새로운 개발

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ALLIMAND NEW DEVELOPMENT IN PRESS PART: THE NAOS SHOE PRESS

Introduction

For both economical and technical reasons, the widths of the paper machine have reached their limit which can be estimated at 11 meters. Contrary ,to this, the speeds of the paper machine keep rising,: the machines run faster and faster, and no one can predict where it will stop.
This significant increase of the paper machines performances is indeed linked to the improvements achieved by the paper machine builders; each of the main components of the production tool is at the center of more and more sophisticated research.
This is how the Allimand Company, after having developed a large range of new products such as the S hydraulic headbox with control profile by dilution, the E former, the A.Sizer, the soft calander or the G reel, has just launched on to the market it's new Naos shoe press.
This shoe press has been validated on a brand new pilot plant installed in Allimand's workshops, in Rives.
Designed for linear pressures up to 1400 kN/m, the Naos shoe press can be integrated into various sorts of press sections and used for as many different grades of papers as printing writing, lwc, newsprint or linerboard.
The goal of this document is to explain the design of the Naos shoe press and to highlight the key-parts of an equipment the papermakers should derive maximum benefit from.

General consideration about paper machine press part

In the last few years, the speed of the paper machine has risen regularly. This speed increase has made ineffective conventional solutions which suffered from open draws or overheating of the covers, in the case of the high pressure presses.
In the mean time, the speed increase made it necessary to get a sufficient dwell time in the press nips to keep the dryness content at a proper level, in order to limit clogging, breaks and steam consumption.
Moreover, the design of the press section must take into account some important physical properties of the paper (such as bulk, printability, stiffness...)

As an answer to these criteria, Allimand have developed its new Naos shoe press.

The first technical choice we had to face was which type of shoe press: hydrodynamic or hydrostatic?

. in the hydrostatic shoe, the oil is injected in the middle of the shoe, which is, in this case, drilled. A film of oil is generated in the middle of the nip. **(see sketch n°1)**
. in the hydrodynamic shoe, the film of oil is generated at the inlet of the shoe, by injecting the oil through a shower. In this case, the shoe is plain.

To understand the reasons of Allimand's choice, let's compare the pressure gradients on the following **sketch (n°2):**

The pressure gradient of the hydrostatic shoe can be divided in 3 parts:

- First part, where the pressure raises steadily
- Second part, where the pressure is constant: the belt is "carried" by the film of oil
- Third part, with quite a steep slope, corresponding to the increase of pressure which is necessary to take out the oil, up to the maximum pressure

The pressure gradient of the hydrostatic shoe is rather different and includes only 2 parts:

- First part, where the pressure raises steadily.
- Second part, with a flatter slope, corresponding to a steady increase of the pressure up to the maximum point.

The latter solution presents some interesting advantages:
. the pressure gradient being steadier, the sheet densification will be more uniform, whereas a flat zone in the pressure gradient is not favourable for taking out the water from the sheet.
. on a operating point a view, it's easier to run with a plain shoe than with a shoe equipped with "pockets".
. moreover, the hydraulic running costs are more important with the hydrostatic solution, the size of the pumps and cooling exchanger being larger.

Design of the Naos shoe press (see sketch n°3).

The Naos shoe press includes the following main elements:

. one fixed beam, which supports all the mechanical strength.
. the shoe
. the belt
. the oil inlet and exhaust system.

The linear pressure is achieved through hydraulic cylinders which are fixed on the central beam. These hydraulic cylinders are located every 250 mm approximately. All cylinders work at the same pressure, except the cylinders at both edges of the shoe, which are equipped with an individual pressure control (see **sketch n°4).** The value of the pressure can be set up from the press section control desk.

As various grades can be produced on the same paper machine, it's very important to adjust the pressure gradient to the sort of paper. For instance, a paper with a high freeness content will require a rather smooth slope of pressure gradient.

The length of the shoe also depends of the grades of paper. For the sensitive paper or thin paper, which requires a lower linear pressure, the shoe will be shorter than for a liner board, which requires the pressure to be as high as possible.

Despite the fact that the geometry and the radius curve of the shoe is determined by the diameter of the counter press, it's of prime necessity for the operator to be able to modify this pressure gradient (and not only the linear pressure) in case of producing very different types of papers.

For this reason, each extremity of the shoe is mounted on one double effect hydraulic cylinder, making possible the application of a torque on the shoe and, consequently, displacing the tangential points of the pressure slopes (**see sketch n°5**). Again, this modification can easily be made from the control desk.

The belt is made of polyurethane. It can be either plain or grooved, depending on the location of the shoe press and the grades of paper.
The belt is guided by internal tubes. The tension is achieved by hydraulic cylinders.
In normal machine operation, the belt works under a small pressure (typically: 0,1m WC). This pressure is controlled and is used to take out the oil.

The injection and the extraction of the oil is a key-element of the shoe press.
In our design, the injection of oil is made just at the outlet of the nip; this ensures the cooling down of the film of oil before entering the nip. The oil temperature at the inlet should be around 40/50°C. The increase of temperature at the outlet is around 10°C.
The system is designed for working both in bottom or in top position (**see sketch n°6**).
For the high speed machine, the centrifugal forces apply the film against the internal part of the belt; for low speed machines, the film remains stuck by the superficial tension.
Regarding the extraction of the oil, the system is equipped with a siphon, placed in the middle of the beam, which works under a slight vacuum. On the edges, the oil is captured by a deflector, collected in a pan and sent back to the hydraulic unit. The same quality of oil is used for all the hydraulic cylinders and the film inside the belt.

Naos shoe press: the pilot plant

Allimand has installed a pilot plant in 2003. The characteristics of this pilot are the following:

Maximum speed: 1800 m/min
Maximum pressure: 1400 kN/m
Width: 1000 mm
Belt diameter: 1270 mm
Counter press diameter: 1546 mm
Motor power: 315 kW

The goal of the pilot plant is to validate the shoe press mechanically and hydraulically, and to proceed to various on-line measurements, in order to check if they match with the theory.

The following parameters are measured:
. air pressure inside the belt
. linear and hydraulic pressure
. tangential pressure on the shoe
. oil temperature at the inlet and the outlet of the shoe.
. motor torque

In the following diagrams, we have summarized the most interesting results:

. Power = f (speed, pressure) **(sketch n°7)**

Power can be estimated thanks to the linear relationship between speed and pressure.

. Outlet oil temperature = f(speed, pressure) **(sketch n° 8)**

The most important parameter is speed with a non linear evolution, pressure produced linear evolution.

. Outlet temperature = f(flow) for constant speed and flows **(sketch n° 9)**

There is a minimum flow required for cooling the belt, but there is a maximal flow which has no consequences on the temperature.

. Power = f (oil temperature) **(sketch n°10)**

There is a reducing of mechanical power consumption with an increasement oil temperature, but there is a reduction of the life of the belt too.

The results are encouraging ; the pilot plant has worked continuously for several hours at maximum speed and maximum pressure, without any failure.
The trials have proven the efficiency of the Naos shoe press design, which can be installed in many different configurations of press sections, such as:

Sketch n° 11: printing writing paper/ copy paper

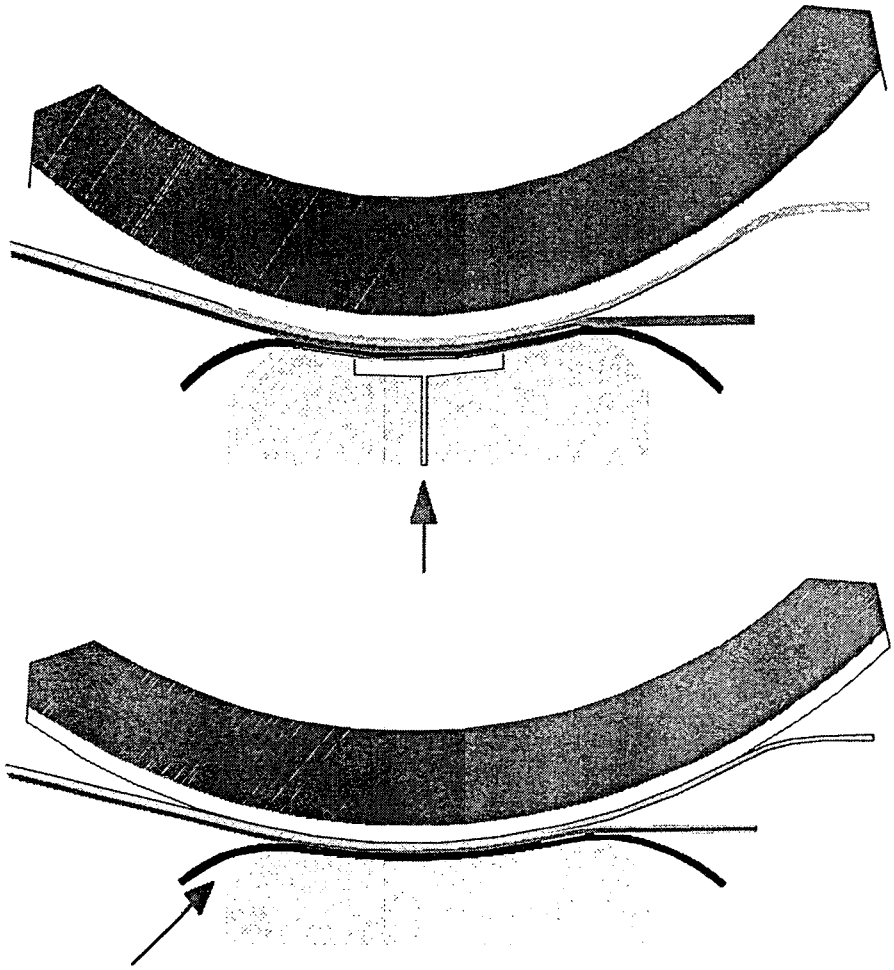
Sketch n° 12 : LWC, newsprint

Sketch n° 13: newsprint paper, liner /fluting

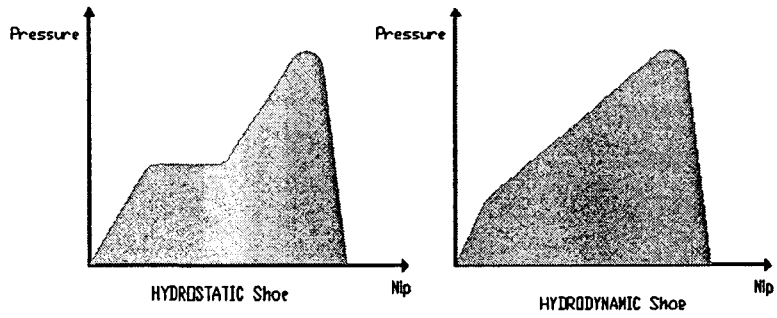
The ALLIMAND Company is at your disposal to study any project which might include such a shoe press on your paper machine.

Bertrand DIDIER
Sales Engineer
ALLIMAND Paper Machinery

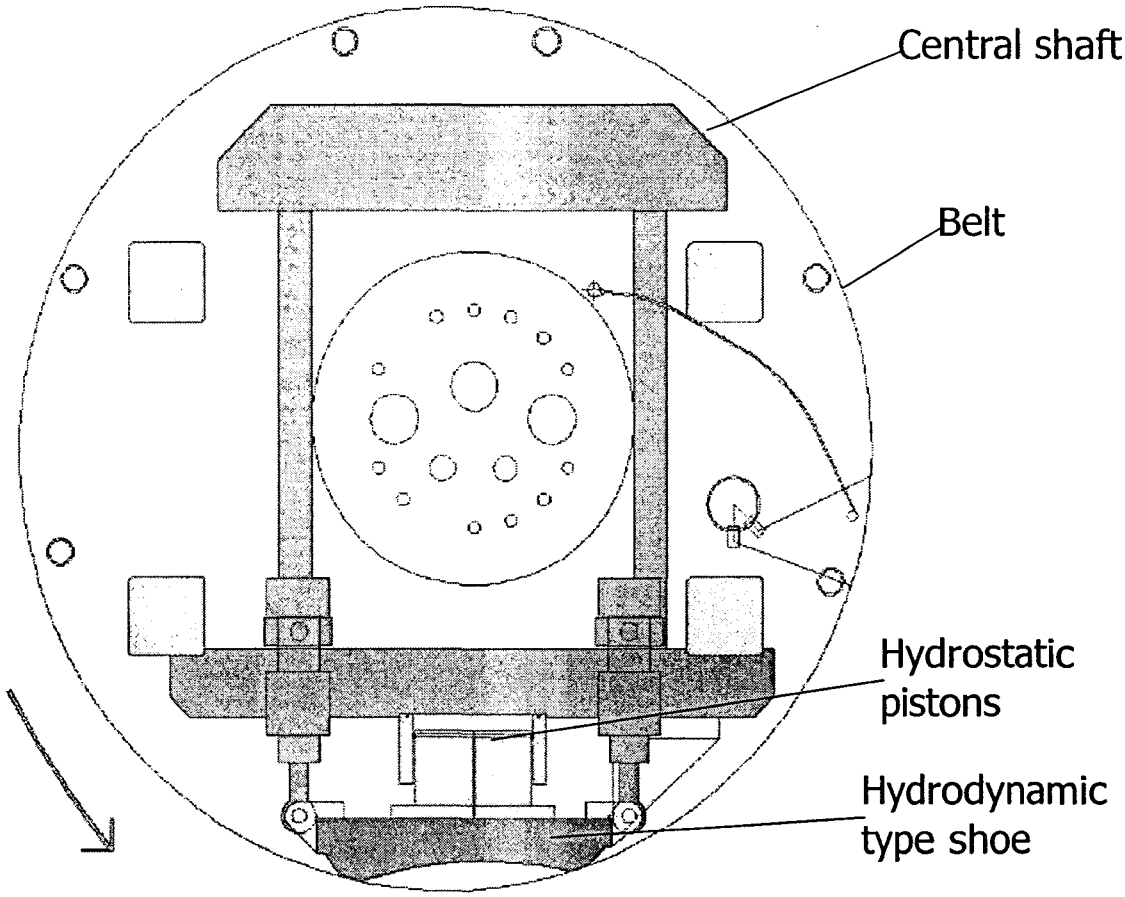
Sketch n° 1



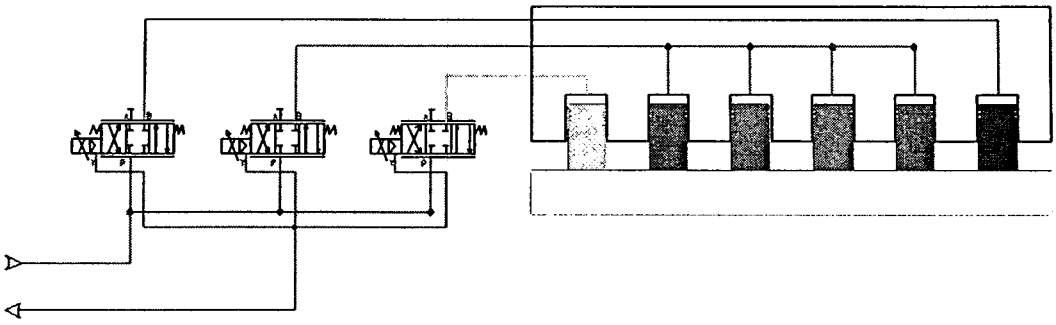
Sketch n° 2



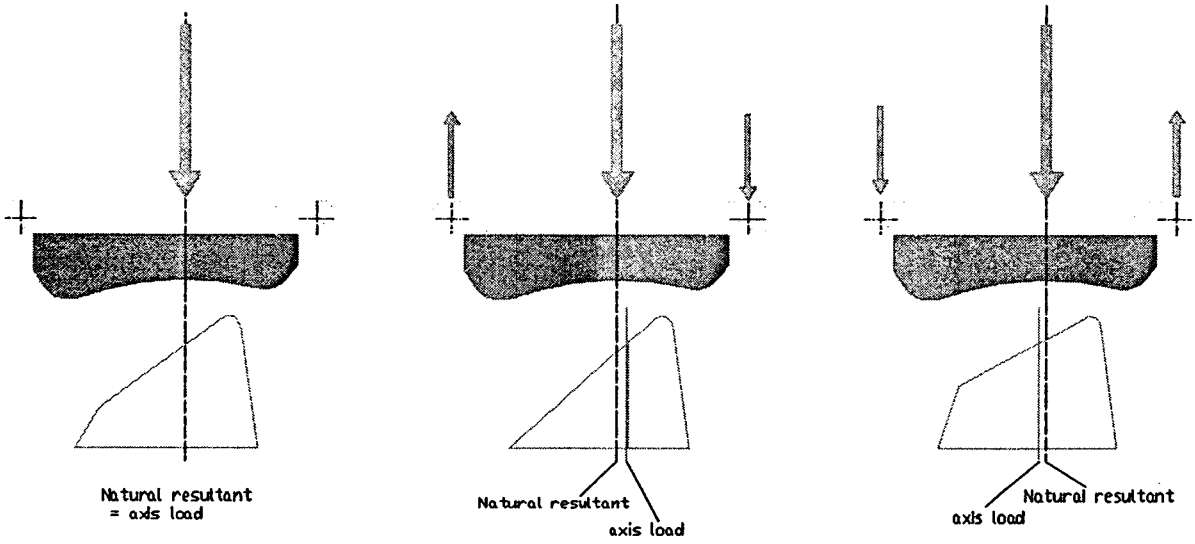
Sketch n° 3



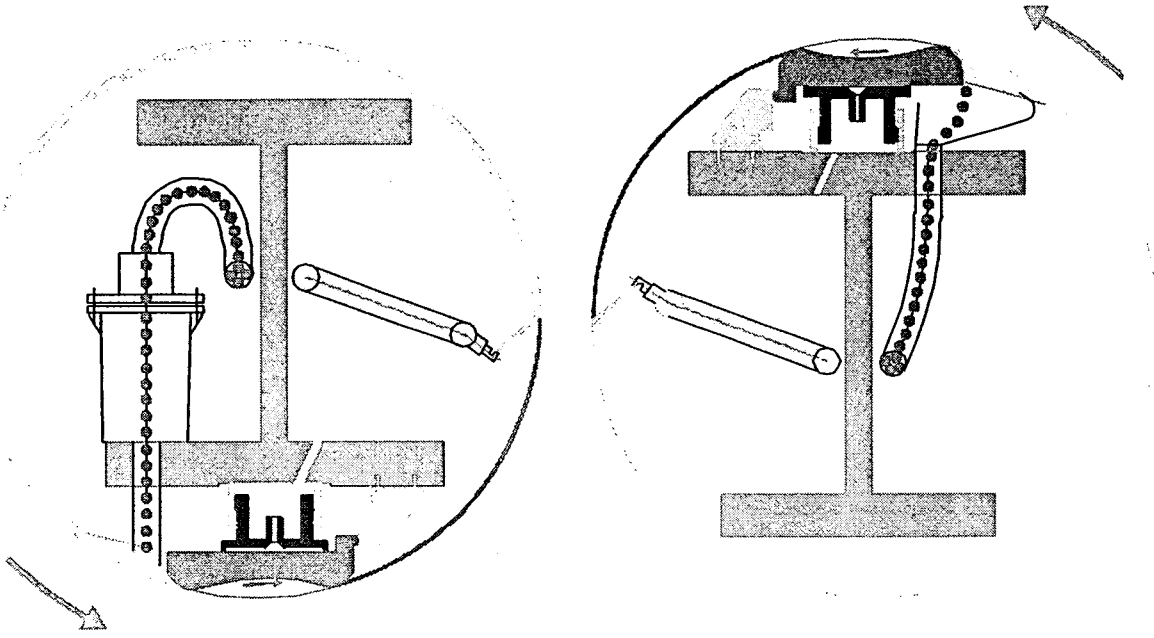
Sketch n° 4



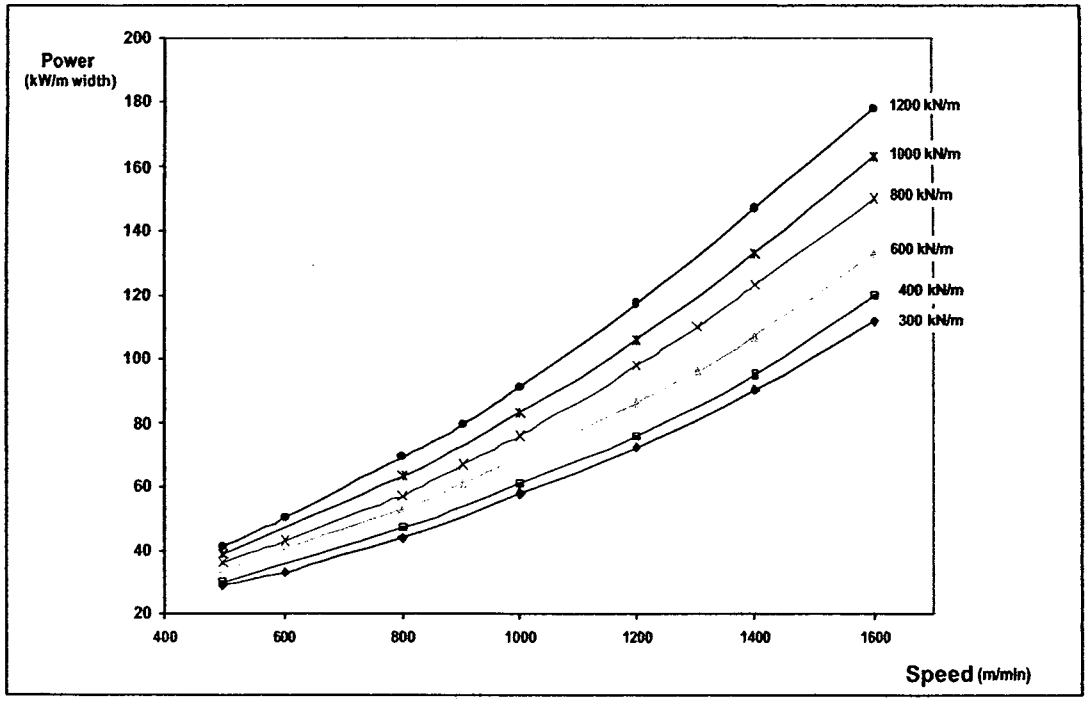
Sketch n° 5



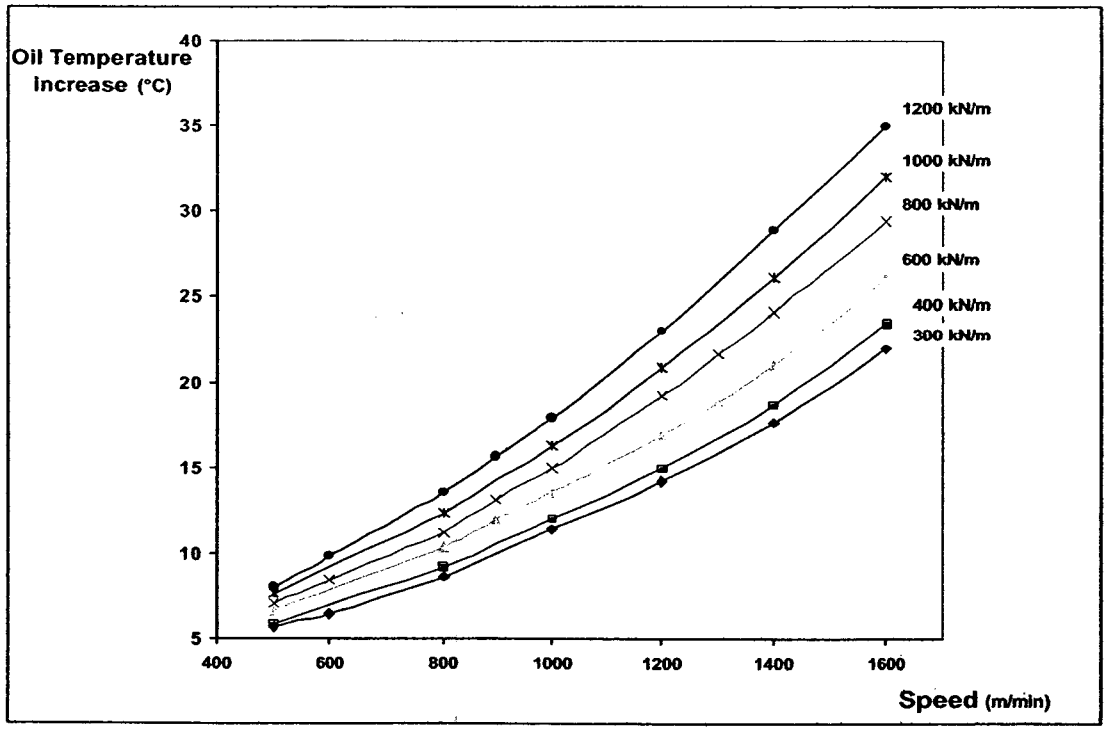
Sketch n° 6



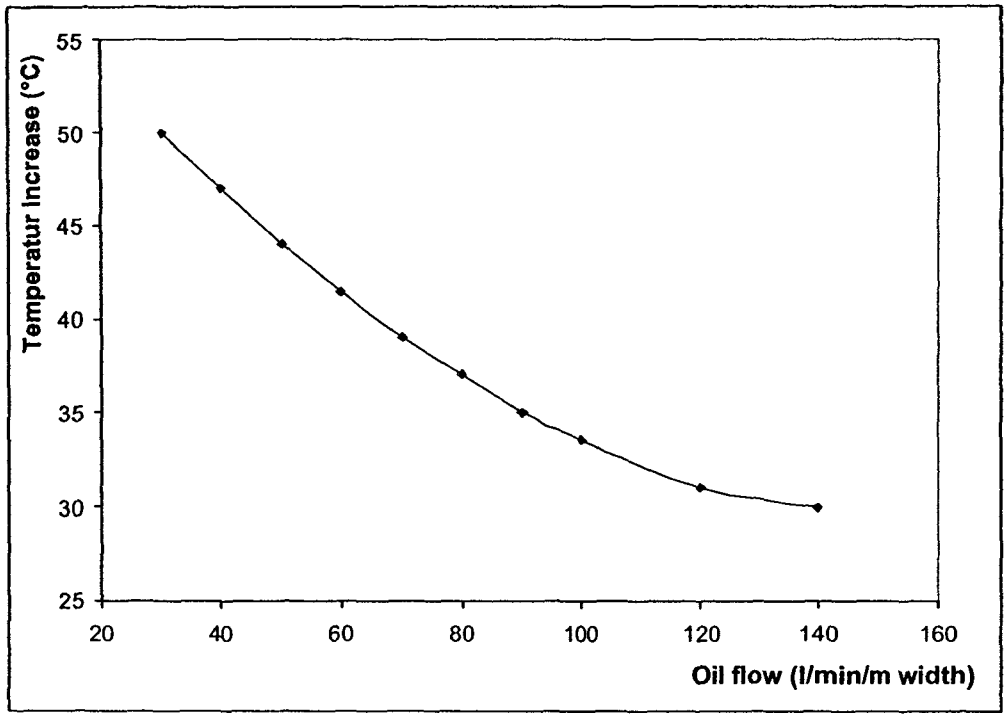
Sketch n° 7



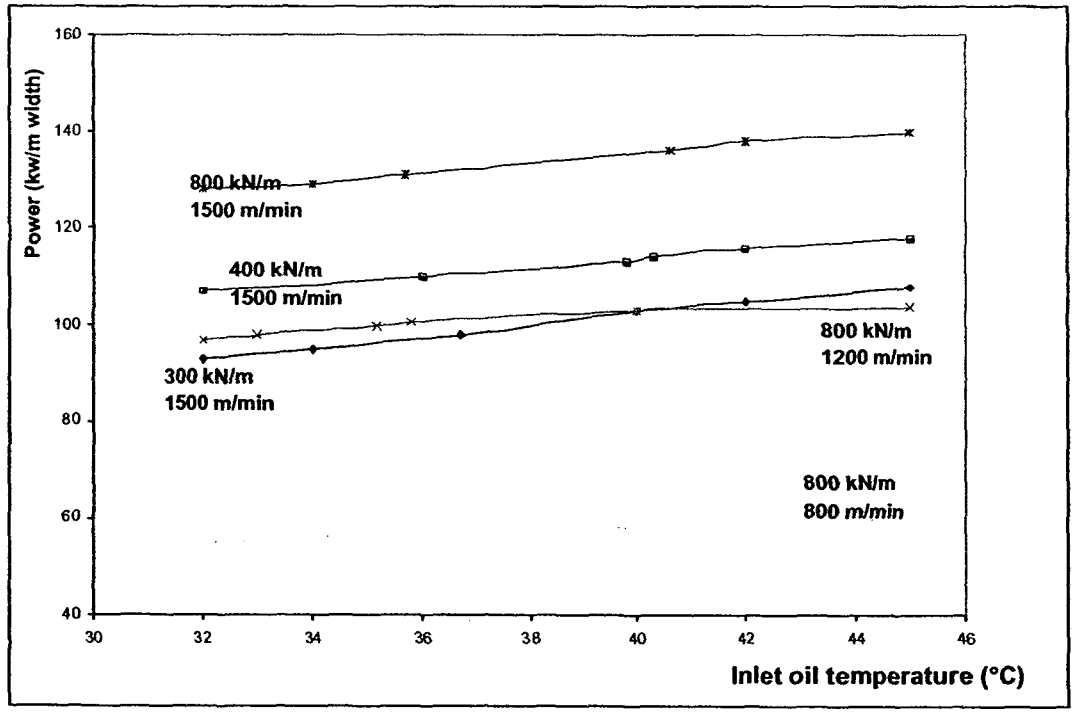
Sketch n° 8



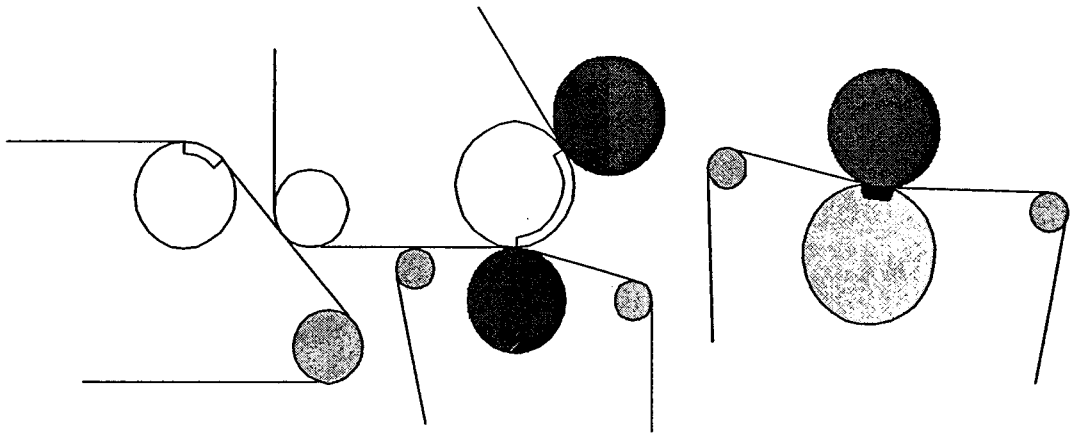
Sketch n° 9



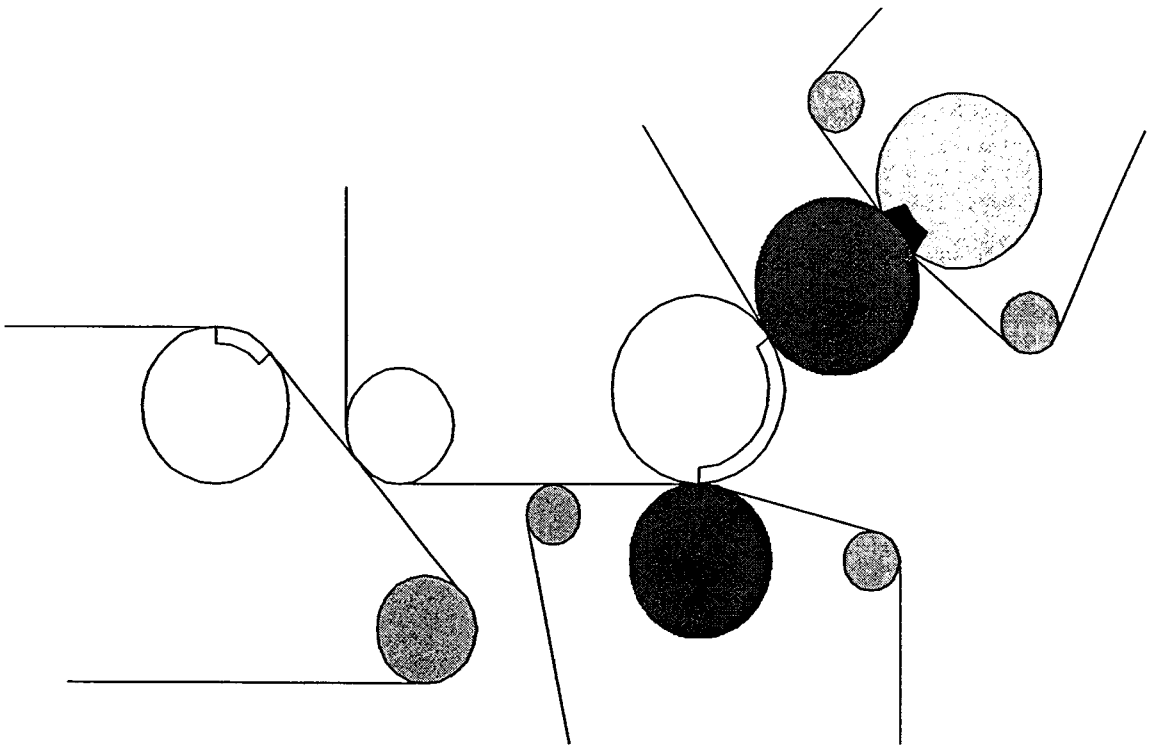
Sketch n° 10



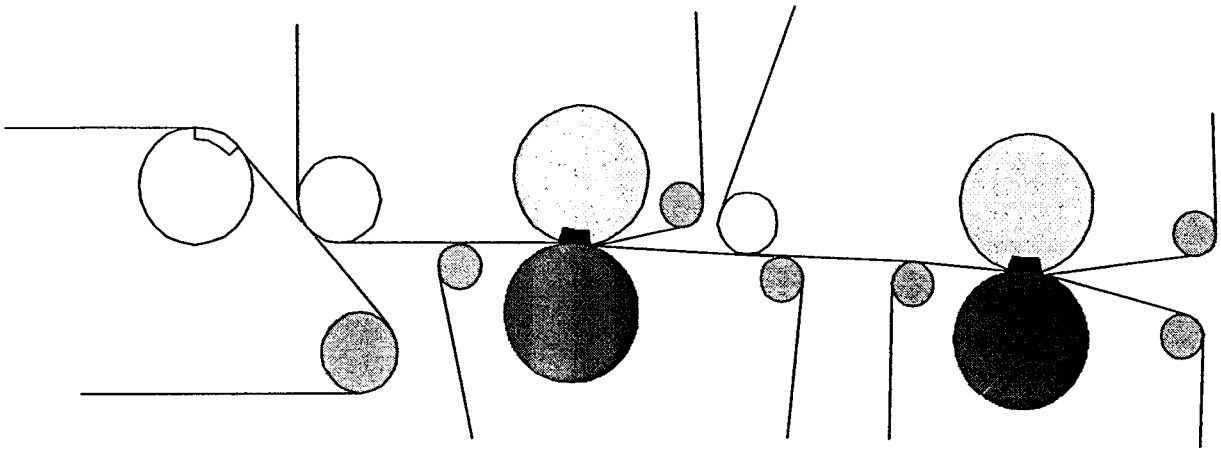
Sketch n° 11



Sketch n° 12



Sketch n° 13

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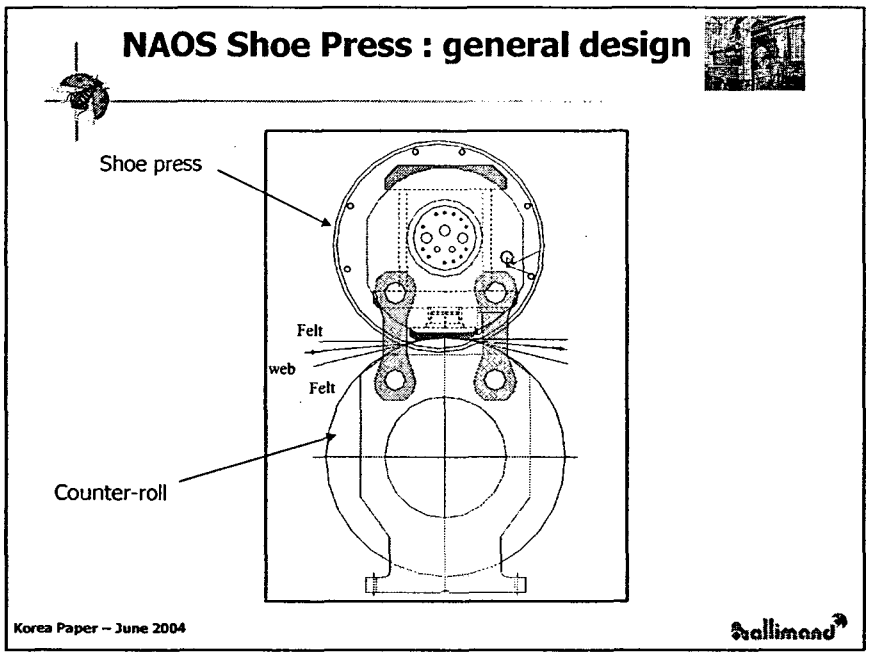
NAOS Shoe Press : general design
Shoe press
Felt
web
Felt
Counter-roll
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NAOS Shoe Press : the shoe

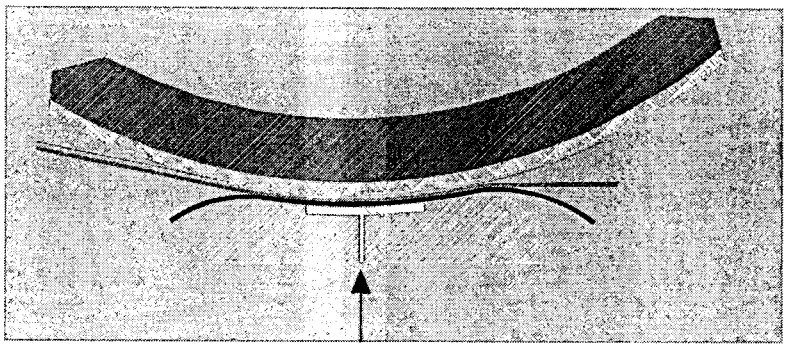
Hydrostatic or hydrodynamic?

NAOS Shoe Press : the shoe

Comparison between a hydrodynamic & a hydrostatic shoe

Hydrostatic :

The oil is injected in the middle of the shoe

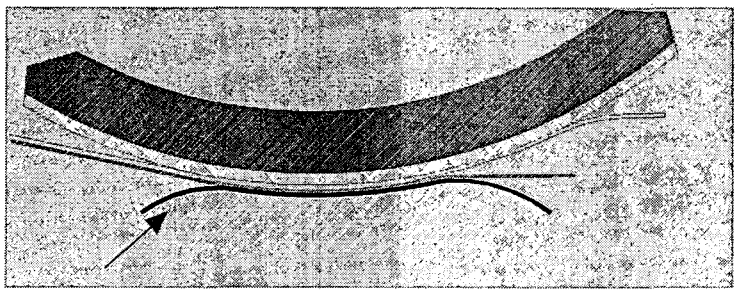


NAOS Shoe Press : the shoe

Comparison between a hydrodynamic & a hydrostatic shoe

Hydrodynamic :

The oil film is generated at the inlet of the shoe



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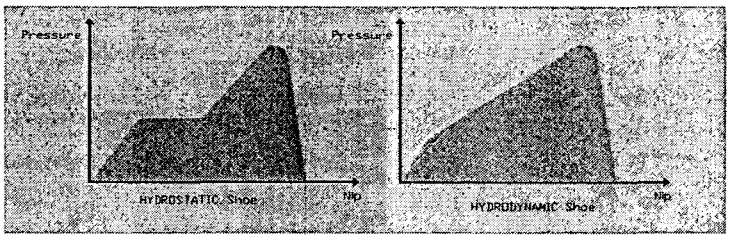
NAOS Shoe Press : the shoe

Comparison between a hydrodynamic & a hydrostatic shoe

Pressure gradient in the Nip



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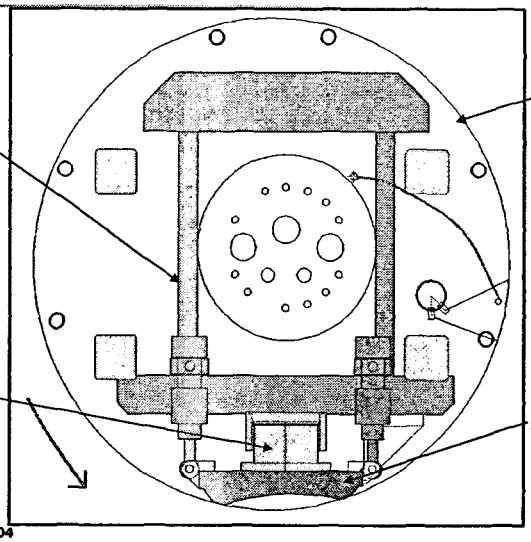
NAOS Shoe Press : the shoe

Advantages of the hydrodynamic shoe

- Steadier pressure gradient throughout the Nip
- More uniform sheet densification
- Better bulk
- Easier running with a plain shoe
- Lower hydraulic cost (pumps, exchangers ...)

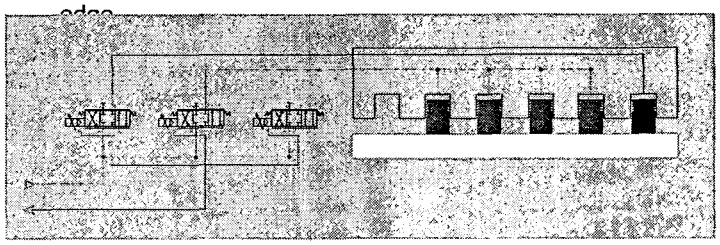
Conclusion : the ALLIMAND Shoe Press is of the hydrodynamic type

NAOS Shoe Press : the pressure device



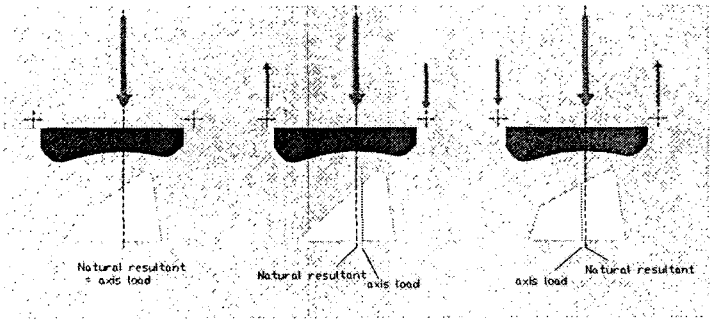
NAOS Shoe Press : the pressure device

- The linear pressure is achieved through hydraulic cylinders which are fixed on the central shaft
- These cylinders are located every 250 mm
- Possibility of having an individual pressure control on the edge



NAOS Shoe Press : the pressure device

Possibility of creating an offset to modify the pressure curve in the Nip



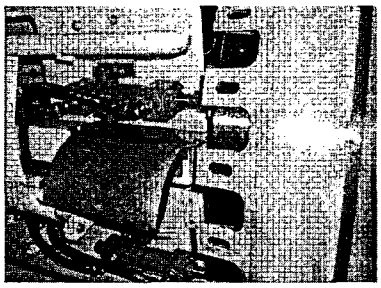
NAOS Shoe Press : the belt

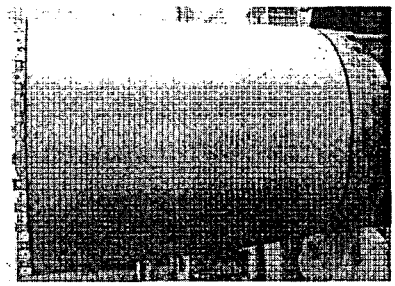
Main data

- Material : polyurethane
- Type : plain or grooved
- Thickness : 4,2 to 5,4 mm
- Maximal temperature : 80 °C

NAOS Shoe Press : the belt

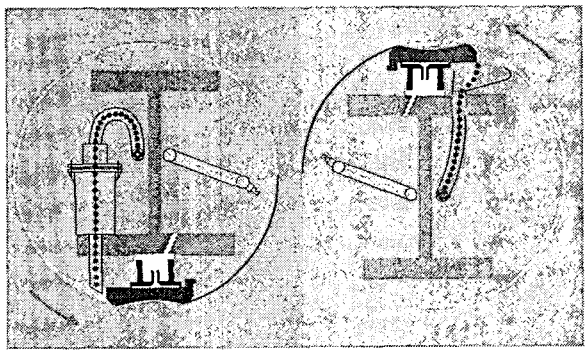
- Guided by tubes all around the belt
- Stretches through hydraulic cylinders



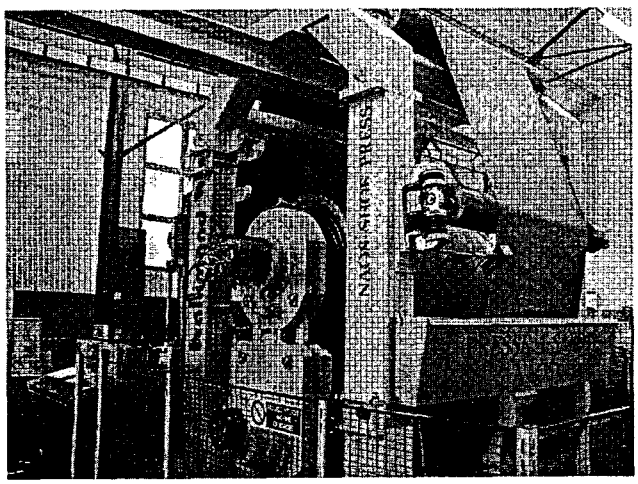


NAOS Shoe Press : the film of oil

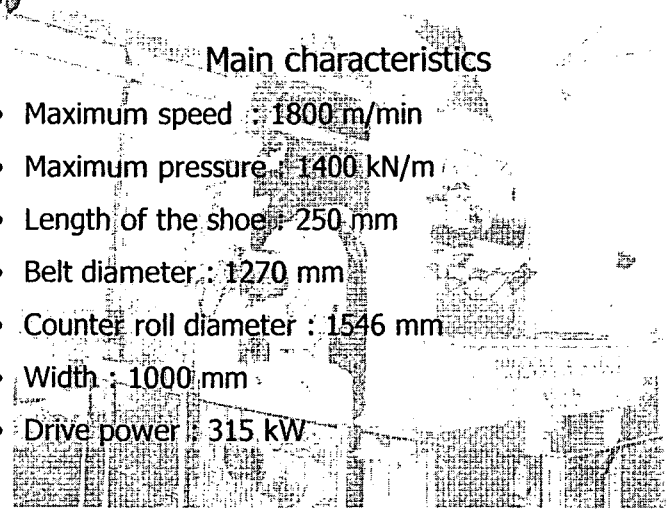
- The oil is injected at the outlet of the Nip through a shower
- The oil is extracted through a scoop



NAOS Shoe Press : the pilot plant



NAOS Shoe Press : the pilot plant



Main characteristics

- Maximum speed : 1800 m/min
- Maximum pressure : 1400 kN/m
- Length of the shoe : 250 mm
- Belt diameter : 1270 mm
- Counter roll diameter : 1546 mm
- Width : 1000 mm
- Drive power : 315 kW

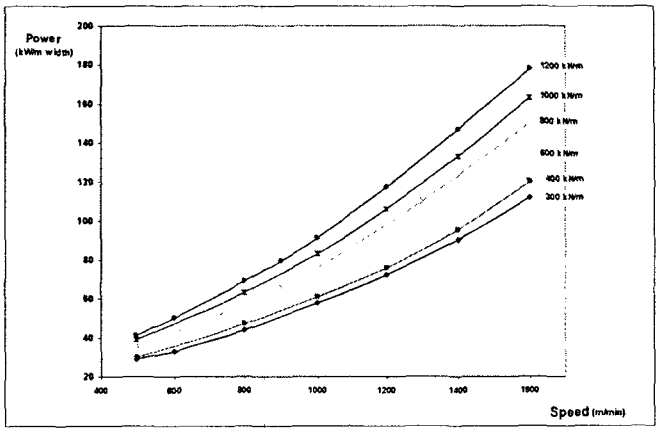
NAOS Shoe Press : the pilot plant

Main measured parameters

- Air pressure inside the belt
- Linear pressure
- Tangential effort on the shoe
- Oil temperature at the inlet and outlet of the shoe
- Speed
- Motor torque

NAOS Shoe Press : experimental results

Power – Speed



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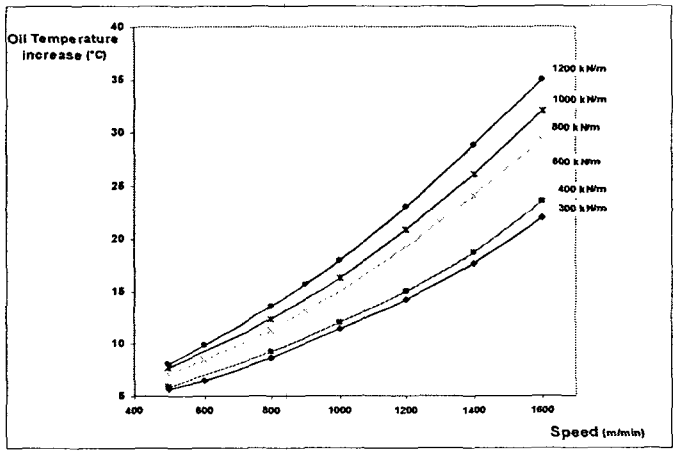
NAOS Shoe Press : experimental results

Oil temperature increase – Speed



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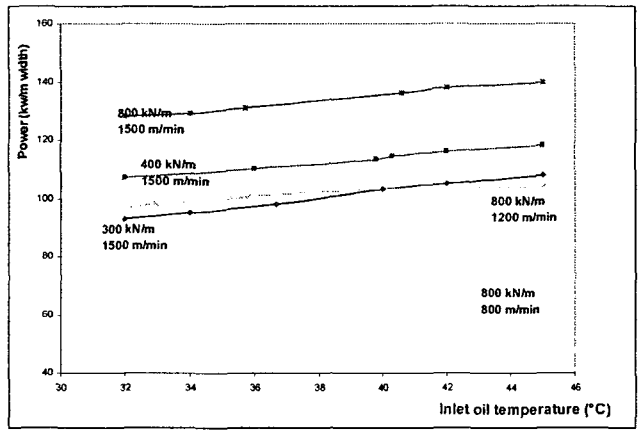
NAOS Shoe Press : experimental results

Power – Temperature



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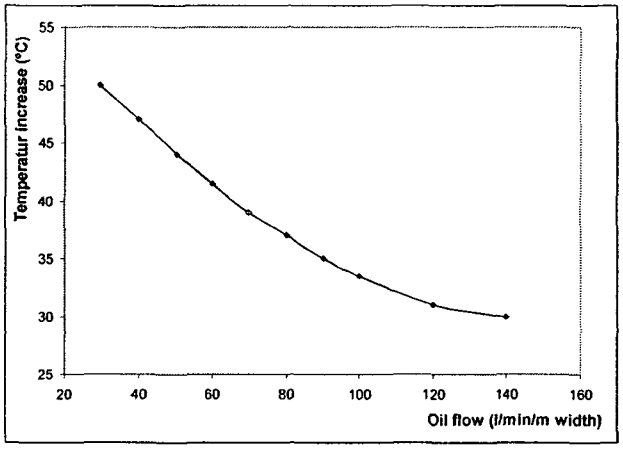
NAOS Shoe Press : experimental results

Oil temperature – flow



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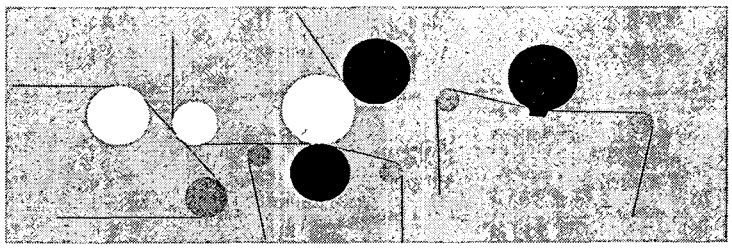
CONCLUSION

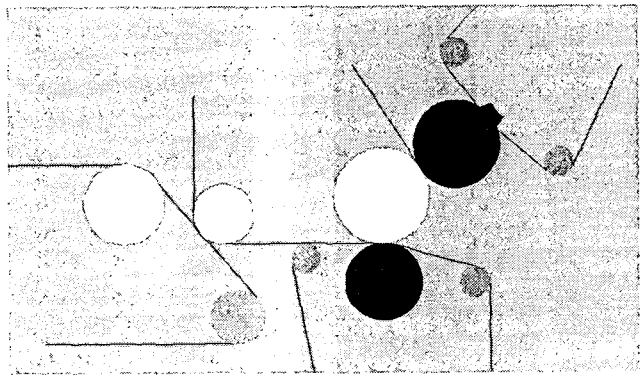
- The trials on our pilot plant have proven the efficiency of the NAOS shoe press design, hydraulically and mechanically

- Such a shoe press can be installed in various press configurations, such as :

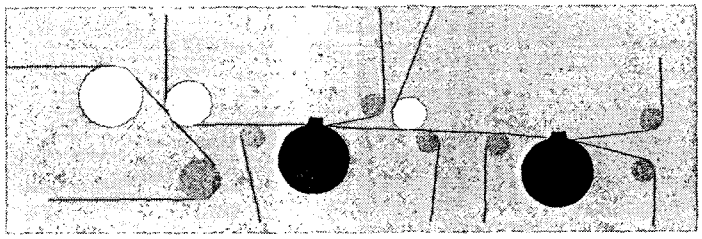
NAOS Shoe Press :
printing writing & copy paper



NAOS Shoe Press :
LWC & newsprint paper



NAOS Shoe Press :
newsprint, liner & fluting




Thank you for your attention
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