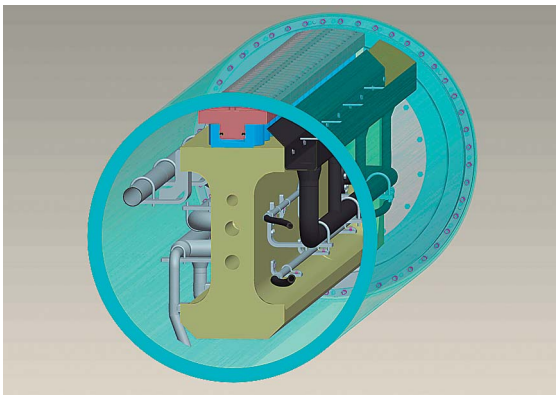

Energy-saving press roll

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With environmental problems including CO_2 emission becoming more serious day by day, all autonomous bodies and industrial organizations are implementing countermeasures. Mitsubishi Heavy Industries Ltd. (MHI) has recently developed a new press roll, reported in this paper, which is effective for power saving. This press roll is designed to greatly reduce power loss from oil agitation by efficiently collecting and scavenging the lubrication oil inside the roll. This system roll has also been shown to be effective in reducing the temperature of the scavenged oil. So far, seven units of rolls of this type have been delivered to users.

1. Introduction

Global environment problems such as global warming due to CO_2 emission are becoming more serious day by day, and all autonomous bodies and industrial organizations are seriously engaged in countermeasures. Factors such as soaring oil prices have also been worsening the situation recently, and the paper industry has been taking various countermeasures including power saving.

Meanwhile, in many recent cases, the need for faster operation of paper making machines is being traded for power saving: the faster the machine operation, the greater the power saving effect. MHI has long been promoting such countermeasures and has developed a press roll that saves power effectively in the area of press parts which reportedly occupy a high percentage of power consumption in the paper making process. This paper reports on the details of this development work.

2. Structure of the MHI paper machine press

Fig. 1 shows the structure of the MHI paper machine press roll. In this paper, the case of MH Shoe Press C Roll is shown as a representative example. In order to support the large load from the shoe module, which amounts to approximately 1 000 kN/m, many shoes are arranged on the center shaft of the Press C Roll and support the inner surface of the roll shell through oil film.

Fig. 2 shows the power saving concept. In the Press C Roll, an ideal lubrication oil film is formed between the multi-hybrid shoes and the shell's inner surface to resist the load from the shoe module[(1)]. For this purpose, it is necessary to supply enough oil to the leading edge of the shoes.

At this time, when there is no scavenging oil pan, the excess oil at the shoes' leading edge is scraped off.

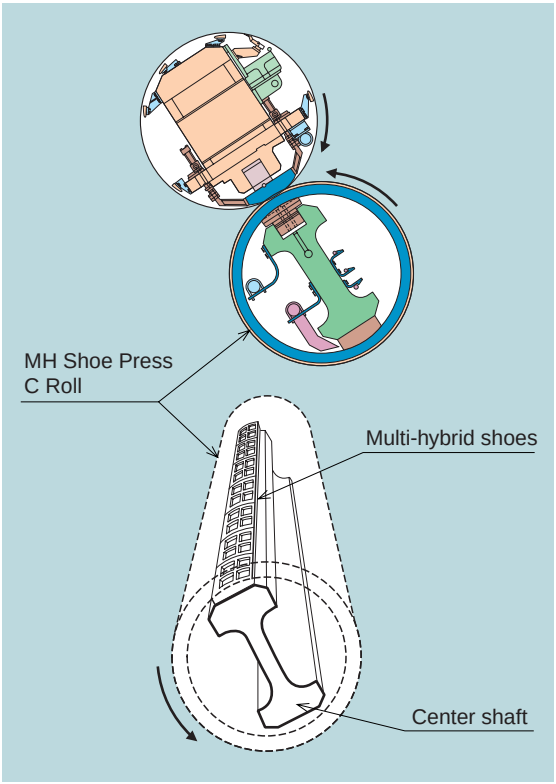

Fig. 1 Structure of MHI paper machine press
Shoe module and Press C Roll configurations are shown.

Accordingly, when the oil circulates inside the roll, it tends to power loss from oil agitation when coming into contact with various points. This is a particularly serious problem in the case of the latest high-speed paper machines.

However, with the newly developed scavenging oil pan system, enough oil is supplied to the leading edge of the shoes and only the excess oil is immediately recovered, drastically reducing the power loss from oil agitation. This reduction of power loss from oil agitation is the main point of the power saving.

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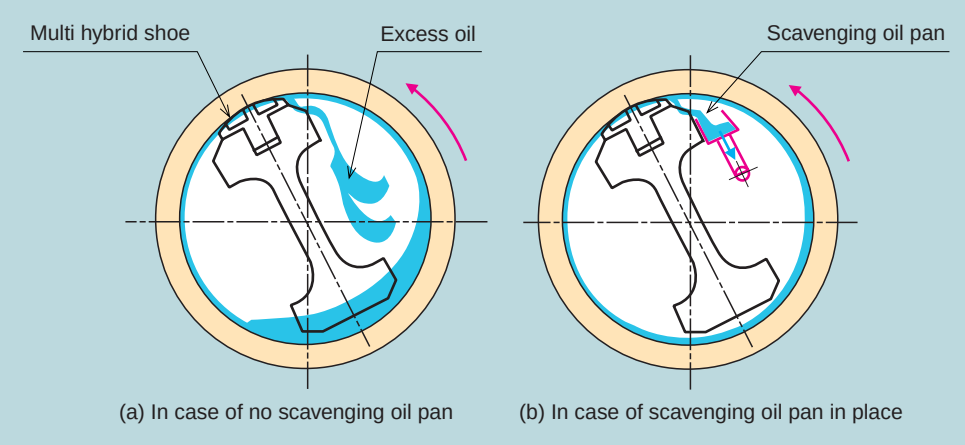


Fig. 2 Power saving concept
Conceptual drawing of reduction of agitating power by adoption of scavenging oil pan. Excess contact of oil against shoes will be eliminated immediately.

Meanwhile, the circulating lubrication oil also takes on the role of cooling the roll itself and the reduced power consumption also contributes greatly to reducing the temperature of the lubrication oil. In other words, the scavenging oil temperature is lower on exit from the roll. These effects allow us to anticipate a thicker lubrication oil film, better protection of the roll cover, prevention of lubrication oil deterioration and other benefits.

3. Machine operating results

MHI has already delivered seven units of the scavenging oil pan system rolls including other types to be described below, and the effectiveness of each unit has been proven. This paper reports on the performance record of one that was delivered to a user company.

Fig. 3 shows the performance record of power saving and scavenging oil temperature reduction of the machine at the said user company. This record is just one example of the reduction effects, which may differ depending on individual operating conditions and machine configuration. It should also be noted that (a) in said Fig. 3 shows power saving at a certain speed as normalized with power before application of the scavenging oil pan.

It can be understood from this data that the reduced power consumption effect involving the power of the press as a whole is 7 to 9% and the scavenging oil temperature reduction effect is 5 to 6 °C. Regarding the reduced power consumption, approximately 8 million yen may be saved when the effect is converted to the machine of MHI's standard press type, size and speed. In addition, if the scavenging oil temperature can be lowered by about 5°C, this will be very effective in eliminating the problem encountered when the machine speed is increased.

4. Optimization of oil scavenging system

Before determining the scavenging oil pan structure, MHI manufactured a small-scale model test roll to visually ascertain the behavior of the working fluid inside

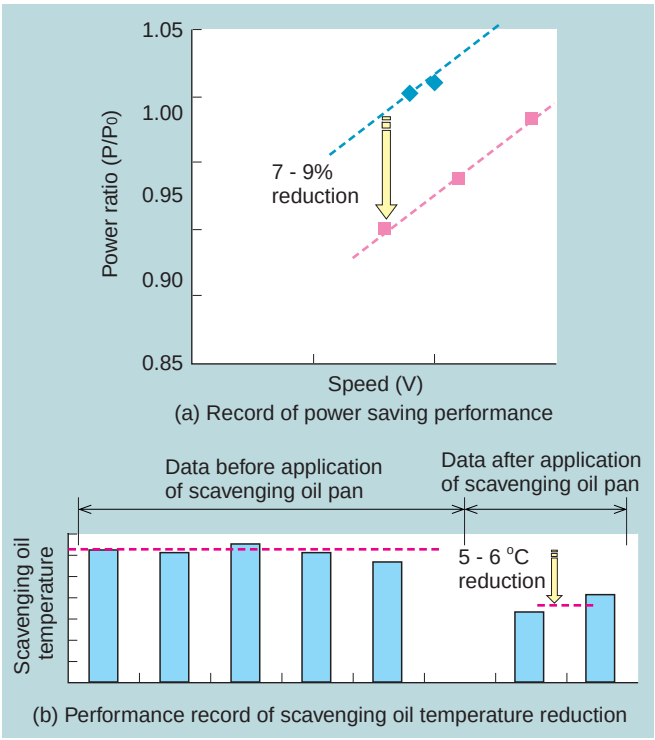
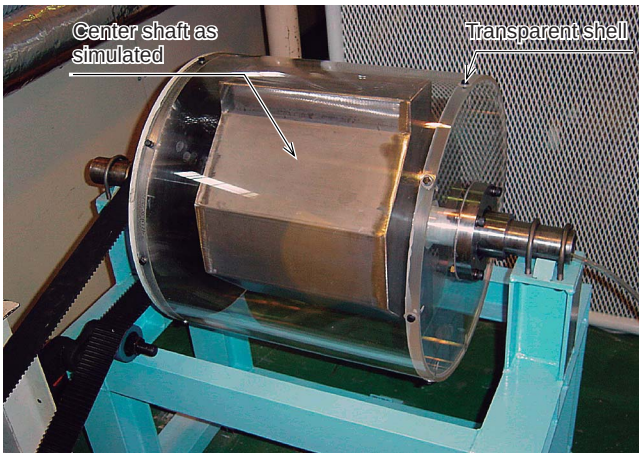


Fig. 3 Record of effects of scavenging oil pan application
Record of power reduction and scavenging oil temperature reduction (example at a user company). Power is normalized with power of the press as a whole at a certain speed before application of scavenging oil pan.

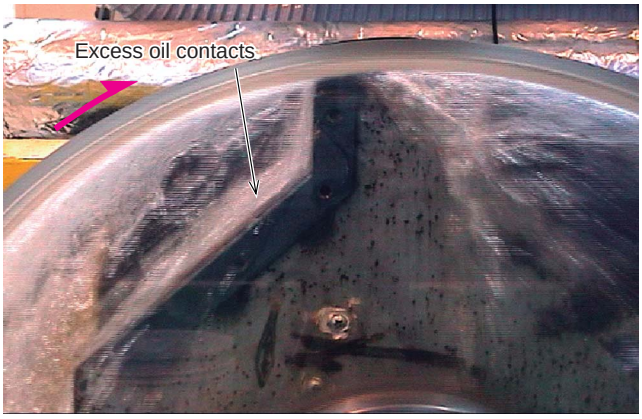
the roll. **Fig. 4** shows the appearance of the model test roll and the behavior of the working fluid.

By means of this test roll operation, it was found that when there is no scavenging oil pan, the excess working fluid that comes in contact with the shoes changes its direction, falls, and is then brought up again to the rotating inner shell surface where it is again pushed against the shoes, repeating the cascading phenomenon.

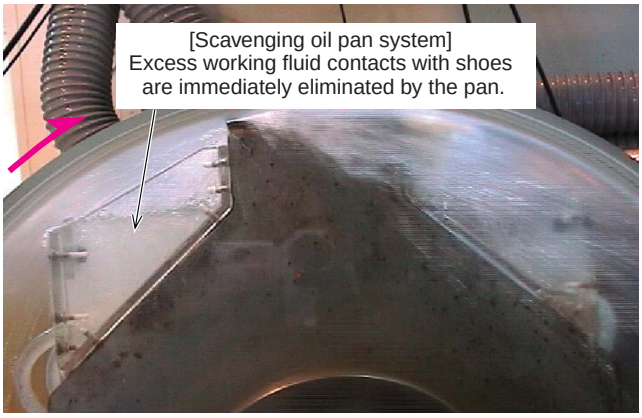
When the scavenging oil pan is installed, however, most of the scavenging oil is recovered immediately by the pan and no disturbance of the fluid on the shoes' leading edge is observed. This fact thus seems to contribute greatly to reducing the agitating power.



(a) Appearance of model test machine



(b) Behavior of working fluid (without scavenging oil pan)



(c) Behavior of working fluid (with scavenging oil pan in place)

Fig. 4 Small-scale model test machine
The behavior of the working oil inside could be visually observed by fast rotation of the test roll made of transparent shell.

5. Analysis of the effects

The various effects described in the preceding section can generally be explained by numerical calculations. The following section will present an estimation and the analysis results of these effects.

The power loss generated inside the Press C Roll consists mainly of the following:

(1) Shoe viscous frictional power loss
(2) Power loss from oil agitation inside the roll
(3) Others

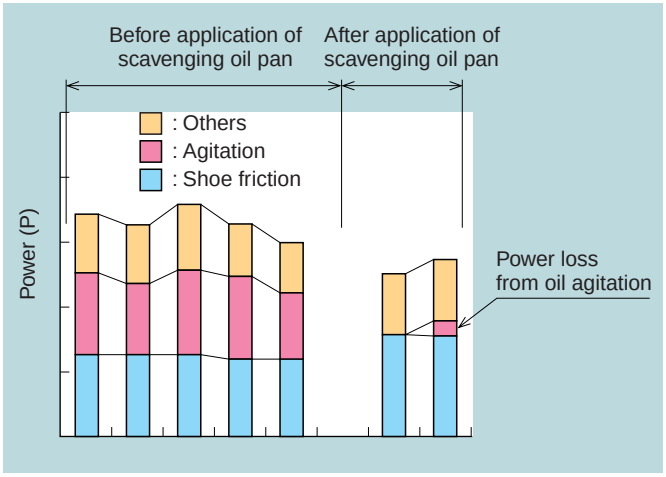


Fig. 5 Component power and estimation of scavenged oil pan effects
Application of the scavenging oil pan greatly reduced the power loss from oil agitation. The item "Others" includes pump power, etc.

Estimation of these power losses and reduction effects has been made by applying MHI's theoretical estimation method. A power loss and scavenging oil temperature estimation system was created with heat balance taken into consideration, and analyses were then made.

Fig. 5 shows the analytical results of the Shoe Press C Roll power. The item "Others" in this figure includes pump power, etc. This figure confirms that before application of the scavenging oil pan, the power loss from oil agitation occupied as large a portion as the shoe viscous frictional power loss.

By contrast, it can be understood from Fig. 5 that after application of the scavenging oil pan, a large part of the power loss from oil agitation could be removed, contributing to power saving.

These simulation results have also shown that the anticipated reductions had for the most part been attained.

6. Application to other types

The preceding section dealt with Press C Roll of the so-called center roll type. In other cases, the scavenging oil pan was applied to the self loading type; the dynamic shoe type was treated for power saving; and various other measures were taken. In this section, an example of application to the self loading type will be introduced.

Fig. 6 shows a conceptual drawing of scavenging oil pan installation in the case of the self loading type. In the case of the self loading type, the space inside the roll is limited and the shoe stroke is long, so the center roll type scavenger oil pan cannot be applied as is. Through the visualized test with the model machine described above, MHI has established a scavenging oil pan structure and layout that can be sufficiently effective even under such limited conditions. Some such products have already been delivered to user companies.

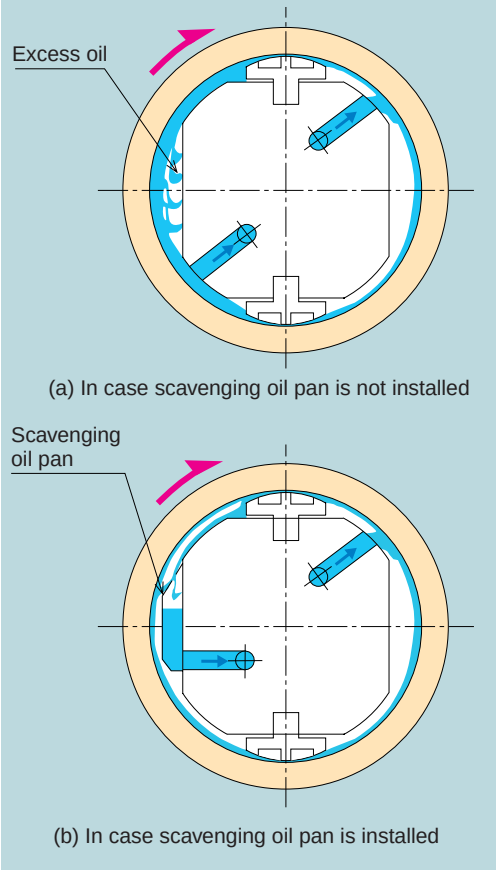


Fig. 6 Application to self loading type
Thin-type scavenging oil pan is applied to the self loading type which has smaller space.

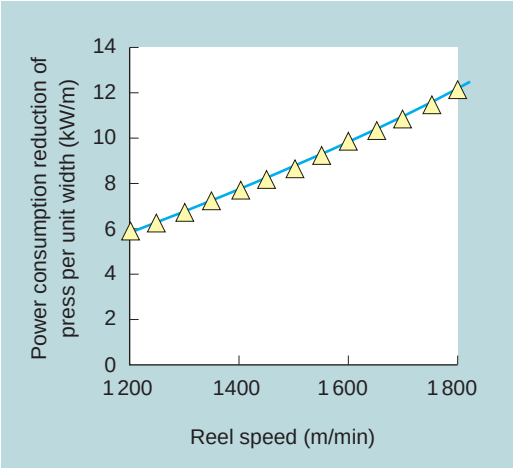


Fig. 7 Estimation of effects on self loading type
Power reduction effect at various speeds as recorded on a commercially operating press at a user company is shown using curve fitting techniques.

Fig. 7 shows the results thereof in which the power reduction effect was estimated from the power record of a user company using the estimation system described in Section 5 above and shown as normalized with reference to wire width. This result has demonstrated the same power saving effect on the self loading type as on the center type.

7. Conclusion

A new type of press roll that is effective for power saving has been developed. This development was accomplished by restricting the movement of oil inside the roll and effectively scavenging it for the main purpose of reducing the power loss from agitation of the lubrication oil inside the roll, which becomes more significant as the machine speed increases. This effect has been estimated and analyzed by numerical simulation and testing and also proven to be effective in reducing the scavenging oil temperature.

Seven rolls of this type of roller have so far been delivered to users including the one introduced herein, and the effectiveness of this type of roller has been recognized by these users.

This innovation is applicable, though under some restricted conditions, to the shoe calender as well as to the press part center roll type and self loading type dealt with in this report. Many variations exist. MHI will continue to study power saving techniques to meet the needs of the customers.

As mentioned in this paper, the scavenging oil pan structure, the effect of power reduction, the scavenging oil temperature reduction, etc. may differ depending on the individual machine structure, speed, operating condition, etc. Please contact the business department of MHI to ensure that your needs are met satisfactorily.

Reference

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