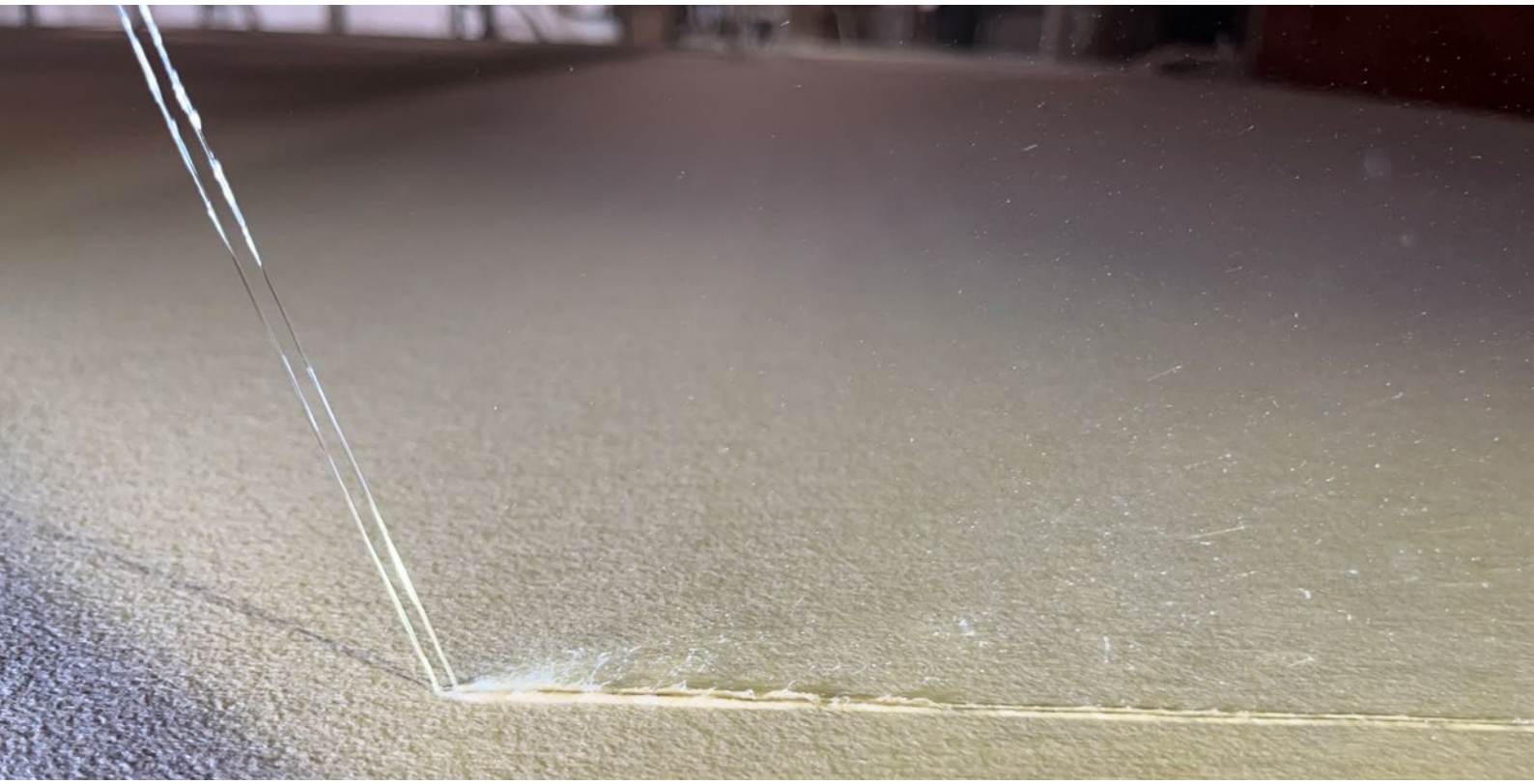
Edge Trim Installations in the Forming Section: Requirements – Operation – Performance



For most papermakers the optimal positioning of the edge trim shower nozzles is a subject in its own right. In fact, good runnability of a paper machine depends to a significant extent on the problem-free operation of the edge trims. If they work efficiently, this pays off in several ways: A low break level, smooth sheet transfer at the pick up, the prevention both of sheet drop-off and edge trim following the pick-up felt together with trouble-free sheet feeding.

In practice, sheet breaks in the press section and even in the dryers, at the size press or in the coater can originate from faults in the sheet edge which are caused by the edge trims (Fig.1+2). Break cameras installed at appropriate points on the machine and synchronised in real time can record the same point on the sheet and prove this.

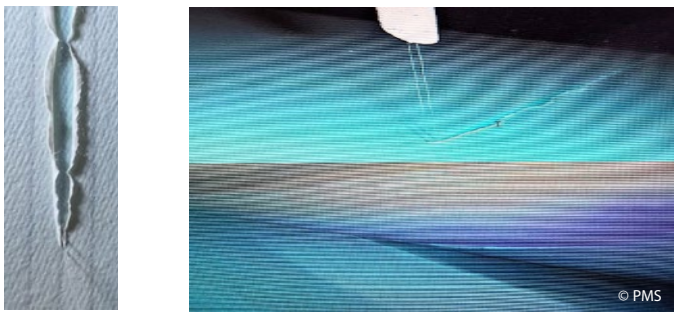


Fig. 1 + 2: Problems caused by edge trim shower nozzles

For evaluation of the jet characteristics of edge trims and also for observing the quality of the trim cut whilst the machine is running the use of a hand stroboscope is recommended. This should be set at a frequency of approx. 50 – 60 Hz and positioned flat above the fabric onto the jet of the edge trim (Fig. 3). Observations then become possible which cannot be achieved with normal lighting.

Fig. 3 Trim cut control

In this article, we would like to provide information on common causes of malfunctions. However, individual constructional and production factors influence the functioning of the edge trims.

The quality of the water jet

A good laminar flow of the water jet is essential for a clean edge trim (Fig. 4). This means that the jet should be thin and "smooth". It should avoid incorporation of air, have an even cross-section and should hit the sheet with sufficient pressure. A turbulent jet (Fig. 5) which breaks up into individual droplets before hitting the sheet, creates a dirty cut, sometimes not right through to the fabric, and in addition causes severe fibre misting.

Fig. 4 Laminar jet

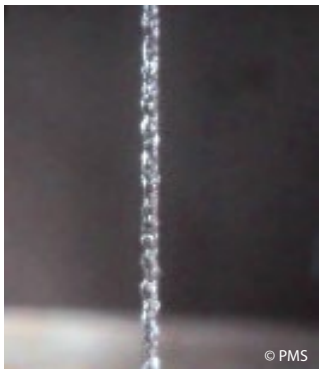


Fig. 5 Turbulent jet

The quality and precision of the nozzles determines the condition of the water jet as well as a constant water pressure. The usual pressure for edge trims ranges from 15 to 40 bar. The distance between nozzle and sheet should be approx. 70-100 mm.
In the case of a non-laminar water jet there is a danger of damage to the fabric. A turbulent jet can push the MD and CD monofilaments out of alignment (Fig. 6), thereby causing wear at the crossing points and fibrillation to the yarns themselves. As a result the MD tensiles in this area can be significantly reduced, with broken yarns separating themselves from the fabric.

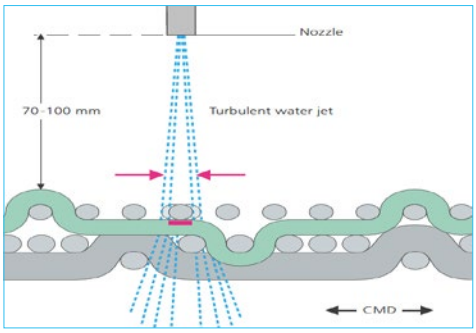


Fig. 6 Possible fabric damage

Modern ruby edge trim nozzles with good jet quality and long life substantially eliminate these problems. However, regular checking of the water jet and the cutting process with the use of the stroboscope is recommended in order to recognise possible changes in good time and to overcome them.

Good water quality is essential for trouble-free nozzle function and the avoidance of plugging. For nozzles with the usual jet diameters of 0.4 to 0.5 mm a filter element with a mesh of maximum 200 µm is necessary. An efficient pre-filtration (50 µm or less) prior to the edge trim pump is also recommended. The temperature of nozzles should be set above the temperature of ambient air so that there is no contamination build up on the nozzles resulting from condensation. Good experiences have been made with water temperatures from 50° to 60° Celsius. Sufficiently high water pressure enables small jet diameters in favour of a perfect edge trim.

Physical Requirements

A clean separation of sheet and edge trim is directly related to the kinetic energy of the water jet. This energy is released when the jet contacts the still very wet fibrous matt of the sheet and in this way separates sheet and trim.

Energy = m x c (Mass x Acceleration); the jet energy therefore is dependent on

a) the mass of the water jet, which is determined by the diameter of the nozzle,
b) the velocity of the water jet, which is influenced by the water pressure.

An optimal relationship of these two dimensions to one another is the major factor in obtaining a perfect edge cut. Papermaking experience shows that a better cut is achieved with a smaller diameter jet. This means that sufficient water pressure should be available.
Obviously, the stock composition, the dry content and the basis weight are also important criteria for the selection of the nozzle. But also its position, the water pressure applied and the correct angle play into the result of the edge cut (see table Fig. 7). As a rule it is recommended with increasing wood content to use nozzles with a smaller jet diameter and to increase the water pressure.

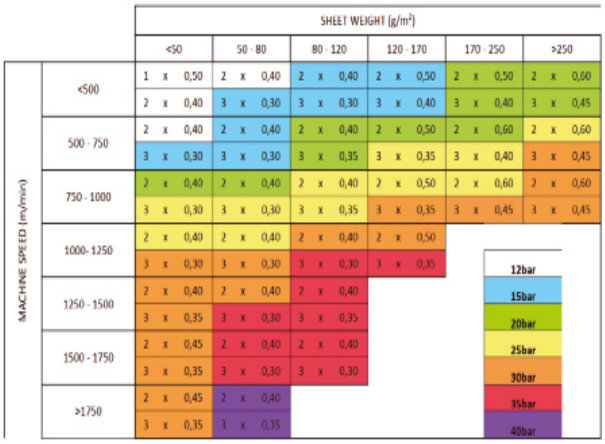


Fig. 7: Jet diameter, water pressure © PMS

Sometimes attempts are made to improve the quality of the edge cut by reducing or increasing the distance between the nozzle and the fabric. However, this will not achieve a lasting improvement with a badly functioning nozzle. By reducing distance, fibre misting is also reduced. However, stock build up on the nozzle is increased with proximity to the fabric. With increased distance more fibre misting occurs as a result of a deterioration in the jet quality and the same level of fibre build up can be expected. A good jet (with laminar flow) at the right angle and with the correct water pressure will always achieve a perfect cut. The distance of nozzle – fabric is only of secondary importance.

Single-jet nozzles – Multiple nozzles in combination

Essentially the water jet should cut through the paper sheet cleanly. At the same time it will also partially penetrate the forming fabric, depending on its structure. At machine speeds up to approx. 500 m/min the use of single-jet nozzles on both single-layer and multi-layer fabrics is generally adequate (see table Fig. 7). Also at medium and higher speeds with very lightweight grades on single-layer or multi-layer fabrics a well-positioned single-jet nozzle can operate satisfactorily.
However, at higher and very high speeds, especially on machines with suction pick-up, two single-jet nozzles positioned one after the other should not be used, since the fibre mist caused by the first nozzle will inevitably cause build up on the second. For this reason twin-jet nozzles (Fig. 8) or even triple-jet nozzles (Fig. 9) should be used.

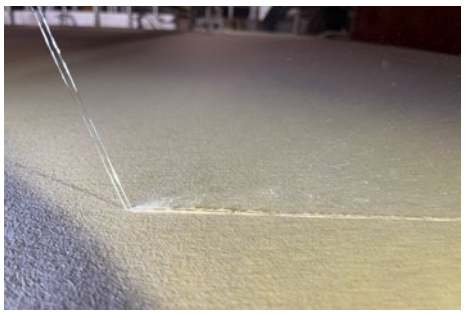


Fig. 8 Twin-jet nozzle

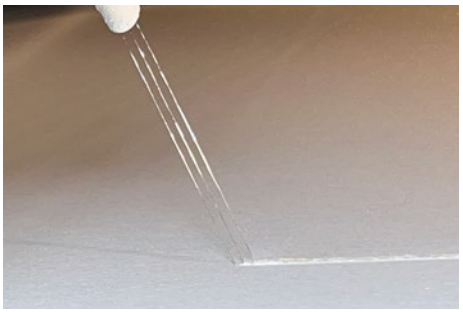


Fig. 9 Triple-jet nozzle

The water jets should be in MD very slightly out of alignment, so that the next jet, although within the cut of the first, is marginally nearer to the fabric edge (Fig. 10 + 11). In this way the edge of the main body of the sheet will be optimally clean and without any additional thickness. At the same time the perfect cut ensures a precise separation of the edge trim at the pick-up.

Fig. 10 Twin-jet nozzle

Fig. 11 Triple-jet nozzle

Angle of nozzle impingement

All edge shower nozzle angles should be optimally adjusted both in relation to the machine direction and the cross direction. With increasing machine speed the angle of impingement of the water jet on the sheet becomes increasingly critical.

The water jet of a slightly obliquely positioned nozzle in the machine direction (between 15° and 40° from the vertical on the fabric) hits the sheet equally obliquely in the machine direction. This positioning prevents or reduces the bounce back effect of the water and with it the generation of fibre mist. In this way a clean cut is obtained.

Additionally the speed difference between the water jet and the fabric must be taken into account. The vectoral jet velocity should be as close as possible to the fabric speed. In this way the jet does not "plow" into the sheet, but uses its energy (mainly) to separate it.

Example: The speed of a jet from a 0.4 mm edge trim nozzle at a water pressure of 20 bar is approx. 2600 m/min; the paper machine is running at a speed of 1200 m/min. In this case a close similarity between the vector of the jet speed (in MD) and the fabric speed is achieved if the angle of the jet (in MD) is at approx. 28° to the vertical. The jet neither "plows" into the sheet, nor is it faster ... which would have the effect of throwing the stock against the pick-up felt.

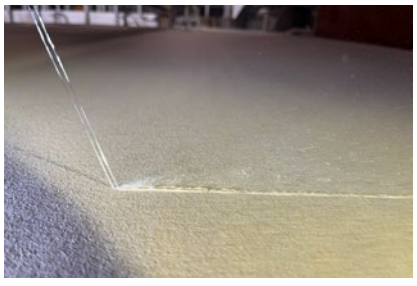


Fig. 12 Jet angle in running direction

In general, the question is whether the edge trims are mounted on or after a suction box. And whether, in the case of positioning on the suction box, the nozzles hit into a suction slot or on a bar. Nowadays, the edge trims are usually installed after a suction box, in Gap former machines in the graphic sector mostly after the HiVac. In packaging Gap formers and Fourdrinier machines, they are widely installed between the last suction box and the couch roll.

If they are mounted on a suction box, it is advisable to let the nozzles hit into a suction slot (Fig. 13). Water, fibres and fines are carried away and not reflected. However, there are also rare cases where the jet hits a bar. As long as this does not cause any problems, there is nothing wrong with this either.

At the same time it is recommended to position the nozzles also slightly obliquely in the cross direction (about 3° - 12° depending on grade, basis weight and speed), so that the jet is directed towards the edge trim. In this way the cut edge of the edge trim is separated securely from the sheet by a light "under wash" (Fig. 14). The sheet itself receives a smooth, clean cut edge and remains attached to the fabric.

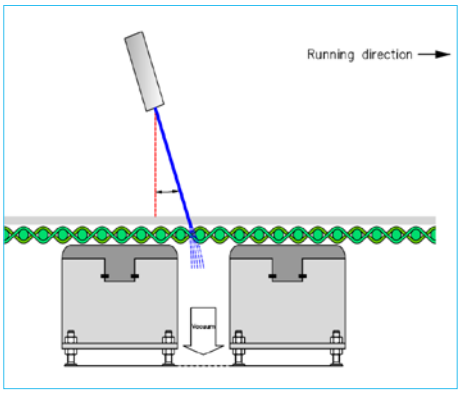


Fig. 13 Water jet diagonal in running direction

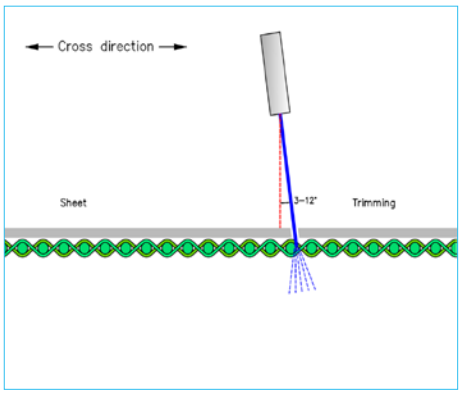


Fig. 14 Water jet diagonal in cross direction

A further reason for the oblique positioning of the nozzles is the ability of an angled jet of water to penetrate multi-layer fabrics (higher caliper, lower support layer). Bounce back effect!
The precise angle of the nozzle positioning must be individually determined by the conditions. This is where the experience of the machine man is critical. There is no precise rule or "scientific formula". However, it is important that the stroboscope is used in observing the water jet and cut.

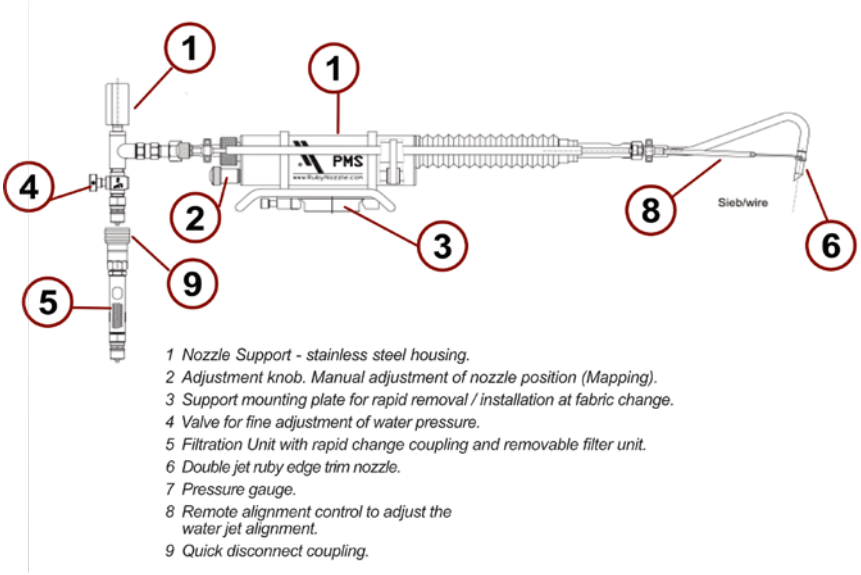
Arrangement of edge trim nozzles

On Fourdrinier machines the edge trim nozzles are generally installed before the suction couch. There is then no problem after the nozzles have created a perfect cut as a further couching of the open cut edges does not occur.

On gap-former machines, particularly at very high speeds, the positioning of the edge trim nozzles is recommended after the couch roll or HiVac – if the construction permits. Positioning before – at least with a less than optimal cut quality – brings the risk that the suction effect to some extent further couches the trimmed sheet, which leads to a poor separation at the pick-up. In this context the correct positioning of the suction zone/s of the pick-up roll should be particularly observed!

Overall the edge trim nozzles must be secure, vibration free and conveniently installed with the capacity for adjustment both in the cross direction and for the required angle movement in the machine direction. Additionally, the total nozzle unit should be easily removable for fabric changes.

Modern edge trim nozzle system © PMS



1 Nozzle Support - stainless steel housing.
2 Adjustment knob. Manual adjustment of nozzle position (Mapping).
3 Support mounting plate for rapid removal / installation at fabric change.
4 Valve for fine adjustment of water pressure.
5 Filtration Unit with rapid change coupling and removable filter unit.
6 Double jet ruby edge trim nozzle.
7 Pressure gauge.
8 Remote alignment control to adjust the water jet alignment.
9 Quick disconnect coupling.

Scheme edge trim nozzle unit © PMS

Summary

The complexities of edge trim shower operation and their dependence on individual factors on the machine show what significance these otherwise "unattractive" installations have for the total functioning of the papermaking operation.

Would you like to optimise your processes? We will be happy to advise you.

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