Press Release

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HEUSCH: Variable Speed Controls on Rollers and Grinding Discs

The current situation

Tanners know it for a long time: “The sharpness of the shaving blade heavily impacts the leather quality.” A blunt blade creates so called “shatter marks” on hides and skins, which later process steps can not compensate or cover-up. The hide or skin is ruined.

The blades’ sharpness very much depends on the grinding process. Granularity, hardness, binding agent and abrasive grit characterize the grinding compound. Experts and machine operators know by experience that compounds can be too fine or too coarse, too soft or too hard and too smooth or too aggressive. Identifying the right balanced grinding compound is an art in itself.

The importance of peripheral speed

At their laboratories HEUSCH engineers had their Eureka moment. The blade sharpness decreased over the lifespan of the grinding disc. In the beginning the grinding disc formed perfectly sharp cutting edges on the blade. Later the sharpness deteriorated drastically. All other parameters of the grinding disc were kept equal. Only the diameter was constantly shrinking. The engineers understood: “The diameter of the disc significantly impacts the grinding performance and the sharpening effect.” It seemed that the shrinking diameter entailed a less sharp cutting edge.

The shrinking diameter induced slower peripheral speeds. In the beginning the grinding disc contacts the blade with higher peripheral speed than at the end. The following formula represents this phenomenon:

$$\pi \times d_{\text{Ødisc}} \times m_{\text{revs}} = V_{\text{peripheral}}$$

$$3.141 \times 0.350\text{m} \times 2880\text{rpm} = V_{\text{beginning}} = 52\text{m/sec}$$

$$3.141 \times 0.175\text{m} \times 2880\text{rpm} = V_{\text{end}} = 26\text{m/sec}$$

Simultaneously to the shrinking diameter the sharpening quality decreased. Adjusting the revolutions of the grinding disc seemed mandatory to compensate for the loss of diameter.

Frequency Inverters for grinding discs

A frequency inverter was installed to allow variable grinding speeds by adjusting the rpm. The plan was to keep $V_{\text{peripheral}}$ constant over the lifespan of the disc by gradually increasing the number of revolutions. It worked! The grinding performance was stabilized.

Installing frequency inverter is no big deal. Programing is much more difficult. What is needed is constant measurement on the disc's diameter. In case a measurement sensor is available programing according to the above formula is quite easy. If sensors aren't available an alternative indicator is needed to reflect the grinding disc's shrinking diameter. Generally HEUSCH suggests utilizing the number of in-feeds for the grinding disc. Both, number of in-feeds and disc diameter correlate to an extent that allows calculating the residual diameter of the grinding disc.

Things become more complicated when the speed of the shaving cylinder is included. In reality not only the grinding disc is spinning but also the shaving cylinder. The same peripheral speed problem applies. During operation the height of the shaving blades will decrease, shrinking the diameter of the complete roller. This leads to reduced peripheral roller speed.

Levelling and Sharpening

Calculation of peripheral speeds for two rotating devices adds complexity to the system. Not only $V_{peripheral}$ for the grinding disc is important but also for the shaving cylinder. Furthermore matters are complicated by two different grinding operations:

1. Levelling

2. Sharpening.

Levelling is a grinding process normally used during the machine setup after re-blading. Before going into production the operator will start levelling the cylinder to bring all blades to the same height. Only after all blades are leveled the operator will start sharpening.

For the calculation of the peripheral speed the rotation direction of the cylinder and grinding disc are important. The shaving cylinder will always rotate in the same direction. Only the rotation direction of the grinding disc can be changed. During levelling disc and cylinder rotate same directional (picture 1); during sharpening both rotate in opposite directions (picture 2). These different directions are of substantial importance to the calculation of $V_{peripheral}$ total.

For levelling the two speeds have to be added:

$$V_{peripheral\ (effective)} = V_{peripheral\ (disc)} + V_{peripheral\ (roller)}$$

Whereas for sharpening the two speeds have to be subtracted:

$$V_{peripheral\ (effective)} = V_{peripheral\ (disc)} - V_{peripheral\ (roller)}$$

During levelling the peripheral speed will be substantially higher than during sharpening. According to above example the grinding disc runs in the beginning at 52m/sec. The cylinder speed is calculated at: 17m/sec. The effective peripheral speed in this case would be 52m/sec + 17m/sec = 69m/sec. The effective peripheral speed during sharpening will be much lower at: 52m/sec – 17m/sec = 35m/sec. Important notice: during levelling the peripheral speed is about 100% higher than sharpening.

Damaged Grinding Discs

This difference in speed bears tremendous risk! A grinding compound giving perfect results in sharpening might reach speeds during levelling beyond manufacturer instruction. By exceeding these limits users run the risk of damaging grinding discs. Such accidents are mainly caused by disregard of speed limits during levelling. Even if the grinding disc seems to be superficially intact after levelling the damage is already done. Grinding discs may explode later during sharpening operations even when speeds are within the limits. Mostly the sharpening isn't the root cause but the previous levelling operation.

A speed difference of 100% is a too substantial to be absorbed by the grinding compound. Tanners are caught between a rock and a hard place. Either the grinding will is well suited for levelling but mediocre for sharpening or vice versa. Tanners are left with two options:

- Use different grinding disc for levelling and sharpening
- Change to variable speed controls for grinding disc and cylinder

Using different grinding compounds for levelling and shaving seems to be an easy fix to the problem. No need to install a frequency inverter. But having two different grinding compounds will put some extra burden on the purchasing department and maintenance organization. Operators and service staff need to be trained on using the right grinding compound. Processes should be implemented and heavily enforced to leave no margin of error to avoid accidents with mistakenly swapped grinding discs.

Customers who really want to unleash the full potential of the findings in their shaving operation have to implement frequency inverters for the shaving cylinder and the grinding disc. The inverters will guarantee optimum peripheral speed for levelling and sharpening. Grinding disc suppliers shall define target peripheral speeds.

Identifying the right target speed will have immediate positive results. Compared to today's unmanaged revolutions, constant peripheral speed will improve sharpness of the blades and shaving quality. Extension of the lifedpsn for blades and grinding disc and positive improvement on workers' safety are additional positive effects.

Shaving quality impact of roller speed

The above calculated shaving cylinder speed of 17m/sec is the peripheral speed with blades at full height (32.5mm). During operation the blade will be consumed to a residual height of 10mm x 2 = 20mm. So the actual cylinder diameter would be down to 320mm compared to 365mm in the beginning. This loss of 45mm will lead to lower peripheral speed of the shaving cylinder. With 15.2m/sec the peripheral speed will be 12% less.

Shatter marks are a result of too low peripheral speed. This lower speed is caused by the shrinking blade height. This is why some tanners never consume the blades completely. They chose early re-blading to avoid too slow peripheral speed. From experience they know: below a certain blade height the shaving result deteriorates.

The moment the blades undercut a certain residual height, the critical peripheral speed cannot be maintained to yield acceptable shaving results. The critical peripheral speed depends on leather type and tanning process. It is obvious that dry shaving requires different speeds than tough automotive leather. To establish the perfect peripheral speed for each leather tests are mandatory.

Frequency inverters on rollers

Cost savings by using frequency inverts seem to be a minor. But re-blading only three times a year instead of four times will make a difference. The reduced downtime of the machine, less blade and copper consumption plus the reduced expenses on balancing will already be enough to pay the frequency inverters. Actually the investment in the upgrade becomes profitable in the second year.

The inverter should be programmed to compensate the blades' height consumption by increasing the roller's rpm to keep the peripheral speed stabile. Modern, large shaving machines have sensors installed to permanently measure blade ends. These sensors can be potentially upgraded to deliver height information. Again applying the peripheral speed formula will help keeping the speed stabile at optimum level.

Summary

Variable speed controls in shaving machines for rollers and grinding discs have been neglected for many years. Today's shaving machines at most tanners are still relying on fixed rpm for rollers and grinding discs ignoring the fundamental laws of physics. As a result tanners have to live with mediocre shaving and leather quality not really taking full advantage of technology. Lifespan of blades and grinding discs are less than actually designed for and expenses for re-blading services are probably 25% higher than planned. The remedy to all this is pretty straight forward: frequency inverters for rollers and grinding discs.