Steel yourself - A good blade is a must in the world of recycling

Effective shredding of certain waste streams is an essential precursor to effective recycling, and steel blades are an important part of the shredding process. Here Len Maskell looks at the effects of wear and tear on blades and considers ways to combat this

by Len Maskell

The media bombard us with warnings about the effects of global warming and climate change, so we know that our resources on this planet are not unlimited. It is impossible not to hear the message as all the information we receive points to the same conclusion – we must recycle as much as we can in the most efficient way possible.

It is a demanding industry. Daily, millions of tonnes of metal, paper, plastics, tyres, porcelain, medical waste and much more are recycled worldwide. The more complex the products we use in our daily life, the tougher the demands put on knives and shredders used in recycling equipment. In most applications, blades and other components suffer from extreme forms of wear and tear.

Industrialization of developing countries means that using the optimum steel blades for recycling becomes even more important. With increasing amounts of waste to manage, processes need to be effective. Downtime for maintenance of machinery and to change worn out parts like knives and shredders is very costly. It is therefore crucial to choose materials that stay sharp and withstand the toughest strain.

During discussions of materials for spare parts or in construction of new recycling machines we come across terms like toughness, ductility and corrosion. In order to make the right choices when it comes to steel blades we need to first understand the things exactly what these terms mean. On the following page is a short glossary highlighting the main problems that can affect steel blades used in recycling.

High performance steel

Uddeholm's range of high quality steels were originally developed to meet the demands of the tooling industry. In this sector high resistance to wear and corrosion, excellent toughness and ductility, and ability to heat treat the steel to high hardness levels are a necessity. Such steel therefore has an advantage over other steels often used in the recycling industry. The steel is manufactured in a different way – a more alloyed chemical composition results in different properties compared with engineering steels. High quality steels are normally more costly than engineering steels but they pay for themselves through higher quality and improved characteristics. This leads to better reliability of the recycling machine and fewer stoppages. A look at some recycling applications and the type of wear they cause on blades is useful. A suggested solution for each of the types of recycling follows, as an indicator of the range of solutions on the market.

Different recycling applications

Recycling of tyres

Recycling of tyres is an extremely demanding process for the active components in the recycling process. The selection of steel for this industry can be a difficult choice because many users of recycling machines put various products through them. During shredding of tyres, a mixed wear phenomenon (both abrasive and adhesive wear) may occur. In cases when wear of different types appear then Uddeholm Sleipner could be a good option to consider. If chipping is the main problem during recycling of tyres, due to foreign object lodges in the tyres, then Uddeholm would recommend its Calmax as the solution.

Tyre fragmentation machine

White goods

Uddeholm Calmax knives, used in the recycling of white goods, have resulted in strong productivity improvement. In the multiple-stage recycling of white goods, such as refrigerators, several knives/blades of varying sizes are used. Very high demands are placed on the knives/blades concerning toughness, ductility and wear resistance. A steel such as Uddeholm Calmax provides an excellent combination of these properties.

Plastic

In the granulation of industrial and household plastic, a sharp edge is required for efficient production. In order to retain this edge the blade must be hard. This is achieved by choosing steel with high content of small carbides, so that chipping is reduced.

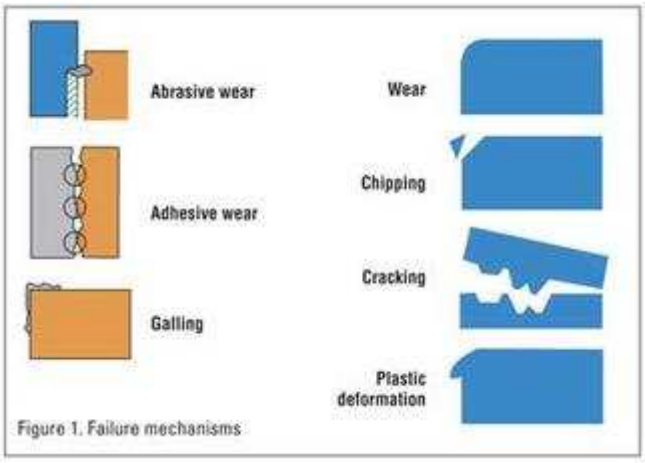

Figure 1. Failure mechanisms

Good toughness and ductility in the material is also important so that the blade doesn't crack or chip. Uddeholm Sleipner would be an excellent material for this application, as it combines good hardness with a good toughness. When a medium to high chipping resistance is required, Uddeholm would recommend Calmax. For maximum performance Uddeholm Vanadis type PM steel with very small, evenly distributed carbides are well suited to the granulation of plastic.

Household waste

Household waste comprises of everything from soft materials to metallic pieces. Uddeholm has successfully produced hammers in a flame-hardened condition for the recycling of household waste. Flame hardening makes the hammer surface wear resistant, while the core remains extremely tough, resisting tool failure.

When maximum performance is needed select Vanadis type PM steels, as the extreme wear resistance guarantees a superior increase in life time. Pre-hardened Uddeholm Calmax or Uddeholm Fermo would offer operational security.

Clipping of paper

In clipping, a sharp cutting edge is essential, as a dull edge tends to pull off the material instead of clipping it. Steel grades with a high content of carbides, good hardness, toughness and ductility, guarantees a sharp edge. The Uddeholm Vanadis steels, for example, enable a sharp cutting edge with less risk of chipping. Using Uddeholm Sleipner or Vanadis 4E you get a combination of good wear resistance with excellent toughness, which increases knife life and lengthens time between changes.

Finding answers

By selecting an optimal steel for the blades and shredders in a specific recycling process, and by considering both the recycling process and the material recycled, a lot of problems and money will be saved long term. Today many recyclers haven't fully understood the impact of the characteristics of the steel in a blade or shredder. When the process doesn't run 24 hours a day there still will be time to stop the process for changes of knives, but is this the most economical way? How much money has been spent on new knives during the lifetime of a knife with an optimized steel choice?

In the future however the situation will be completely different. With more scrap to process, the time for stoppages and the demands put upon the active components in the recycling machine will have a much bigger impact on the total economy of the recycling process; the selection of steel will become crucial.

Types of steel have been specially developed to withstand wear, plastic deformation and corrosion. Depending on the dominant failure mechanism and wear type, an optimal material can be selected for the knife, blade or shredder used in a specific recycling process.

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Commonly used terms for failure mechanisms

Wear: This phenomenon is the most common on all knives and it can be divided into 'abrasive' and 'adhesive' wear. Wear will take place if the steel in the blade or shredder has been selected to give the highest possible 'toughness' without considering its resulting lower 'hardness' level. When selecting steel for blades it is best to look at the various types of wear and tear the particular type of recycling process creates.

Abrasive wear: This takes place when shredding materials that are hard, perhaps with particles of silicon or abrasive products such as brick, stone, filled plastics, etc.

Adhesive wear: This will appear when shredding softer materials like stainless steel, aluminium or copper. To reduce adhesive wear you have to select a tough material with low co-efficient of friction.

Galling: This is an unusual form of wear and tear. Different types of material can build up onto the steel making the blade heavier and causing problems in cutting. This can be avoided by selecting materials with low friction co-efficient properties and increased toughness. Nitriding is a method which can be used to reduce the friction and increase the hardness of the cutting edge.

Ductility: A simplified description of ductility, is a material's ability to resist the formation of a crack on plastic deformation. This means that a knife produced in a ductile material will last longer before cracks are formed (e.g. on stretching beyond the yield limit, so that the material doesn't return to its original form).

Toughness: The ability of a material to absorb energy before breaking, i.e. a knife made of steel with high toughness can be used longer before it breaks which may be simplified as a material's ability to resist the growth of a crack, at an uncontrolled rate to breakage.

Hardness: Usually defined as resistance to penetration, i.e. resistance to permanent deformation when a harder material is pressed against the material's surface.

Chipping/breakage: Chipping, generally occurs when steel has high wear resistance and low toughness.

Tempering back: Occurs when the blades reach a high temperature and perhaps are rubbing together rather than cutting. When this happens, the hardness level of the knife will decrease, with possible formation of fatigue cracks and an early failure as the result.

Plastic deformation: Plastic deformation will take place if the steel does not have the compressive strength to hold the cutting edge, i.e. it doesn't cut it properly. The knife will then deform and rub instead of properly cutting the material which is being recycled.

Corrosion: This occurs due to different gases given off during recycling, or by recycling corrosive material which can contaminate the steel. This can be overcome by selecting a stainless material with good toughness and wear properties.