Forging
How to maximize your production

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Forging – How to maximize your production

We all try to use our time and money wisely. Who wants to waste time or throw money away? Many people today have to travel to work over long distances, and many of us select a car with the most efficient properties. Often these more efficient cars are more expensive but you work out the breakeven point and when the extra cost is paid back. If I suggested to you that a 50 year old car design was the best and most efficient way you could travel to work you would be wise not to listen to my advice. Yet this type of thinking can often be what forging companies use when selecting a die tool steel if they are not careful. We will discuss why this is often the case and what needs to change in the forging industry, so that the correct die steel is selected to solve the most costly problems in the supply chain. The focus will be on the press forging, which is Uddeholms AB's main market, but the principles apply to all hot applications.

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Solving die failure with special tool steels

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Figure 1 shows that cheap is not always good! The YUGO 45 which was sold in the 1980's was based on early 1970's technology. Its performance was terrible compared to cars of its day and you would not use this type of car today for your most efficient form of transport? Why then does the forging industry still use tool steels based on 1930's technology when they are so limited in solving the most important problems facing die life?

It is very important to make your tooling as efficient as possible. Modern forging is a very competitive industry and has to survive in a globalised world where a few percent (%) extra on the cost of a part can be the difference between making a profit and making a loss. The bulk of the industry's customers are large automotive companies who often demand price reductions on each project and often review this throughout a project's lifespan.

The aerospace and special alloy forging industry is a good example where die life is often much lower than the automotive segment, but they still persist in selecting die steels on price rather than looking at what is causing the problem in the first place and how to solve it? To understand how best to do this we must first understand the main failures in forging where big improvements are needed in die life.

Maintain your Dies well

Before we start with the tool steel, it is important to mention good maintenance of your dies is critical to any tool steel working at its best. Pre-heating of the die is one of the most important parts of maximising die life. During the forging operation, metals with a high temperature are formed between the two dies. Due to the heated metal and the much colder room temperature the die can fail very fast. The High temperature of the work material and the low temperature of the die will result in high levels of stress in the die surface. If the stresses become too high, cracks will start to form and will soon lead to failure. To lower the number of stress-build ups in the die, the temperature difference needs to be reduced and this can be done by pre-heating to a range around 150°C to 220°C. The pre-heated die will also result in higher toughness and ductility, which will lower the growth rate of cracks and crack initiation.

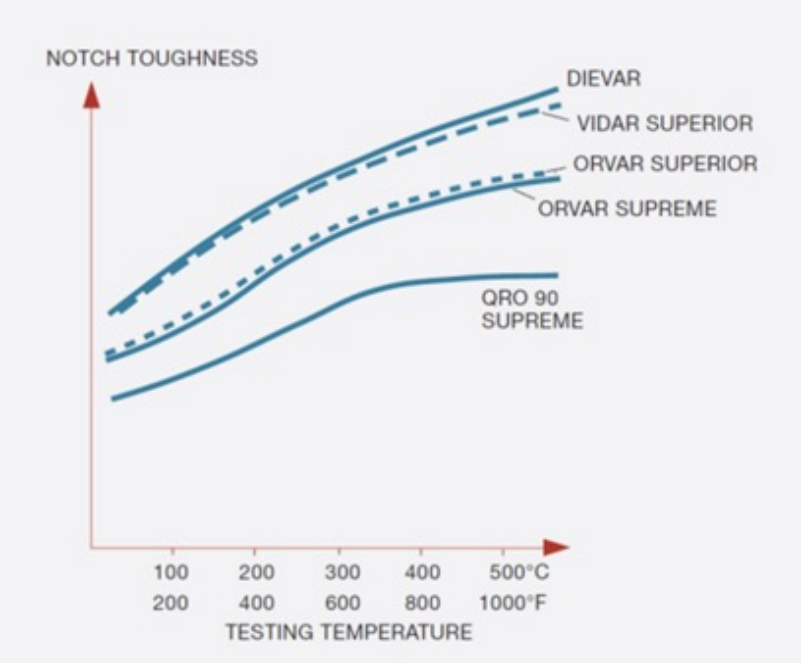

Figure 2 we see how by just heating your die you maximise the potential toughness and reduce the risk of cracking

What is the failure? Are you solving it with your die steel?

If we asked most press forging companies what the main die failure which stops them achieving the maximum die life is, the majority would say ”abrasive wear”. The second could be ”plastic deformation”, but sometimes you can get ”cracking” which can end production very fast. The most common dies steels used today are listed in the table below. We have to ask ourselves, do these solve the biggest problem of abrasive wear and how do they rate with the other 2 problems?

W-Nr/AISI	C	Mn	Si	Cr	Ni	Mo	V
1.2344/H13	0.40	0.35	1.00	5.20	-	1.50	0.90
1.2343/H11	0.36	0.30	1.00	5.00	-	1.30	0.50
1.2714	0.55	0.70	0.30	1.10	1.70	0.50	0.10

Figure 3 shows a chart that compares chemistry of current tool steels, with most dating from before 1940’s. We know that 1.2714 while cheap lacks the properties to attain high hardness, temperback resistance and hot wear. Its biggest strength is its weakness; low hardness gives good tougness but terrible plastic deformation and wear resistance. But are H13 and H11 any better than modern tool steels from Uddeholm?

The answer for the main problem of abrasive wear is no, the chemistries of 1.2344 (also known as H13), 1.2343 (also known as H11) and 1.2714 are all lacking in this area, or they have compromises which we will explore in the next section. At this point we will discard 1.2714! If you want to solve abrasive wear and plastic deformation, then this steel is like a very old low technology car that may get you from A to B, but it does so with a very high running cost…….think the original VW Beetle. This tool steel (1.2714) is very good at being tough, but that is offset with terrible abrasive wear and plastic deformation properties, which is the compromise for good toughness. Often you see this grade no higher than the 40/44HRC range, which makes it good for hammer forging in large dies where toughness is the most desirable property.

Now, if we continue with the car analogy, we move to the 1970's YUGO 45 car based on an even older car and our steels here would be H13 and H11. These tool steels can trace their roots back to the pre-1940 era, but even with process improvements they have not changed much to this day. The YUGO 45 was OK at the cheap price it was sold for and perhaps it was an improvement on the VW Beetle from the 1930s, as was indicated in the promotion picture (fig.1), but not today as a modern efficient car! This mirrors the basic principles of tool steel selection within forging, if you do not focus on the true areas of high cost such as the life time running costs of the tooling. AISI H11 & H13 are cheap, easy to buy and they work OK, but is just OK really what you want? Furthermore, how do these steels compare to modern special chemistry die steels like some on offer from Uddeholms AB?

How to solve your problems with modern tool steels?

To solve these problems of abrasive wear and plastic deformation we need to look at modern tool steels from Uddeholms AB. For example, Uddeholm Unimax uses high hardness combined with good toughness from its chemistry and the ESR process (Electro Slag Refining) to achieve this. The ESR process results in an increased cleanliness, homogeneity and more or less equal properties in all directions of the block or round bar of tool steel. The ESR process is when you take the conventional cast ingot and remelt this through a slag bath which then forms a new purified ingot with these superior properties. It then goes through forging and other processes to give even more superior properties.

If we use the car theme, we could say for example that Unimax is like a modern efficient PHEV (Plug in Hybrid Electric Vehicle) car that uses all the good parts of the old car's technology, like a combustion engine, and combines that with the electric motors and batteries (new chemistry and ESR process).

W-Nr/AISI	C	Mn	Si	Cr	Mo	V	Hardness Range
Uddeholm Unimax	0.50	0.50	0.20	5.00	2.30	0.50	48-58HRC
1.2344/H13	0.40	0.35	1.00	5.20	1.50	0.90	42-54HRC
1.2343/H11	0.36	0.30	1.00	5.00	1.30	0.50	42-52HRC

Figure 4 shows the chemistry of Uddeholm Unimax which gives you superior wear resistance to H13 and H11 with higher hardness possible and increased temperback resistance, also add the ESR process and you have a truly remarkable problem solver.

Unimax has increased Carbon over H13/H11, which allows it to reach the high hardness of 56/58HRC. However, hardness is just one step towards achieving better abrasive wear resistance over H13/H11; you also need to have great temperback resistance, which is achieved with Unimax as it has almost double the amount of Molybdenum which gives Unimax fantastic hot strength to resist temperback effect and the resulting plastic deformation from this drop in hardness.

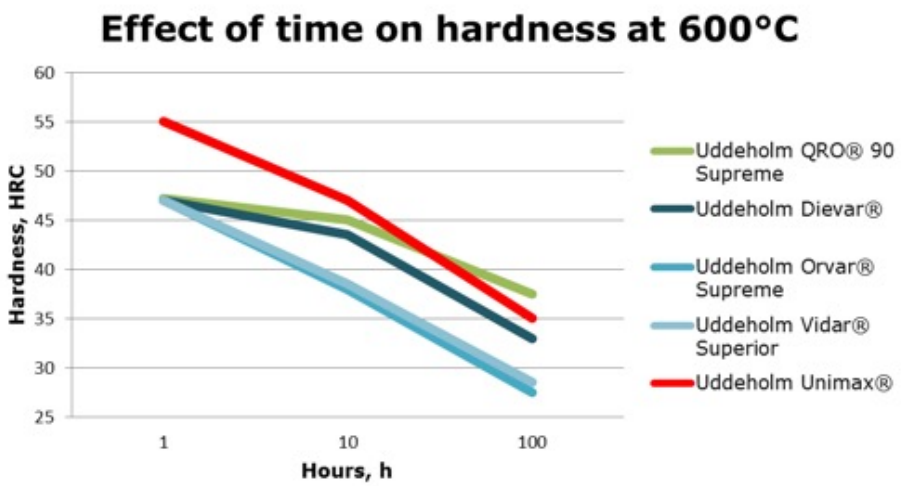

Figure 5 shows the fantastic higher hardness possible with Uddeholm Unimax and its superior temperback resistance. Uddeholm Orvar Supreme is Uddeholm's high quality ESR H13 type and we see the gap is always constant.

We see from the effect on temperature chart above that Unimax takes a long time to temperback because of its ability to reach higher hardness levels than H13, H11, Dievar and QRO90. Unimax maintains this higher level of hardness all the way through the production cycle until over 10 hours, at which point Uddeholms QRO90 starts to outperform it. The benefit is in the first 10 hours where you gain big advantages in extra wear resistance from the high level of hardness. This performance is repeated in countless case studies from customers when using Unimax in high wear applications. Please notice that the grades from Uddeholm, Vidar Superior (modified H11) and Orvar Supreme (H13), while good steels, prove the points made in the first part of this section, that H11 & H13 chemistries do not have the properties to resist temperback effect like the new steels, such as Uddeholm Unimax, Dievar and QRO90 Supreme.

Different Uddeholm tool steels can solve different problems, as we see in the case study in figure 6. Today you may face many urgent problems in production relating to your die steel, so we urge you to step away from your old YUGO 45 (H13/H11) and step into a new more efficient way to get to your desired destination with modern Uddeholm tool steels.

Forging - Uddeholm Unimax

Application:	Press Forging
Working Temp	1150°C
Work Material	Inconel 718
Part Type	Aerospace Blades

	Rival Grade	Uddeholm	Uddeholm	Uddeholm
Steel grade	1.2343 or H11	Dievar	Unimax	QRO90 Supreme
HRC	52-54	50-52	55-57	50-52
Main failure	Plastic deformation & Hot wear	Hot wear	Hot wear	Hot wear
Tool life	100 parts	500 parts	750	700

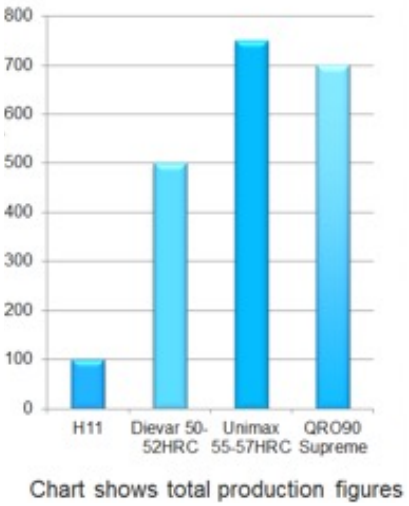

Figure 6 we see the end result of what we have discussed! H11 here gave very limited performance and by uses 3 different Uddeholm problem solvers the company found their best answer with a massive rise in die life.

Manufacturing solutions for generations to come

SHAPING THE WORLD®

We are shaping the world together with the global manufacturing industry. Uddeholm manufactures steel that shapes products used in our every day life. We do it sustainably, fair to people and the environment. Enabling us to continue shaping the world – today and for generations to come.

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