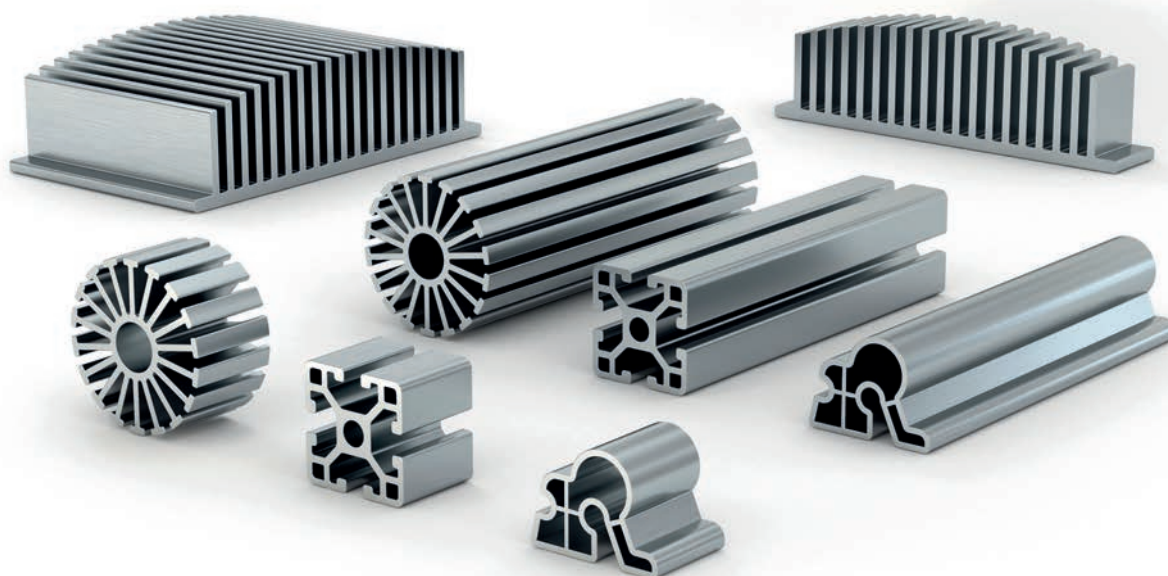


UDDEHOLM TOOL STEELS FOR

# EXTRUSION TOOLING



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Classified according to EU Directive 1999/45/EC  
For further information see our "Material Safety Data Sheets".

Edition: 2, 07.2016



Selecting a tool steel supplier is a key decision for all parties, including the tool maker, the tool user and the end user. Thanks to superior material properties, Uddeholm's customers get reliable tools and components. Our products are always state-of-the-art. Consequently, we have built a reputation as the most innovative tool steel producer in the world.

Uddeholm produce and deliver high quality Swedish tool steel to more than 100,000 customers in over 100 countries. We secure our position as a world-leading supplier of tool steel.

Wherever you are in the manufacturing chain, trust Uddeholm to be your number one partner and tool steel provider for optimal tooling and production economy.

Quite simply, it pays to go for a better steel.

## CONTENTS

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Introduction	4
Uddeholm hot work tool steel for dies and extrusion tooling	5
Tool steel properties for extrusion dies and tooling	6
Material selection for dies and extrusion tooling parts	8
Manufacturing of dies and tooling	12
Tool steel product programme	
– general description	14
– chemical composition	15
Steel and hardness selection	16
Complete extrusion systems	18

## INTRODUCTION

The production base of the Uddeholm company is tool steel; however, our business idea is to sell and market tooling materials and services to tool makers, tool users, machine builders, and their customers, providing the best total economy.

Steel for industrial tools must be of very high quality. This is the primary guarantee that the tool parts produced meet specified requirements. In this context, we maintain that there is a difference between steel and steel; most of our grades are unique to the market—that is why we use our own brand names—and have been developed over the years by our experienced engineers and metallurgists.

However, a first-class tool steel goes only part of the way to providing an optimum solution for a tool user. Hence, Uddeholm's present-day offer stretches beyond that of the traditional steel supplier and includes a wide range of complementary services aimed at ensuring that tool users

really get the best from our tool-material products. In liaison with tool makers, tool users and, in some instances, even end users (i.e. those who use the parts which the tool shall make), we aim to develop complete solutions for optimal economy, of which the supply of the tool material is only one facet. In practical terms, this means that apart from the tooling material and associated know-how, we can in many cases offer services such as machining, heat treatment and even possibilities to assist in tool maintenance and repair e.g. welding service. We are convinced that our policy of supplying services over and above the tooling material is necessary if our customers, particularly tool users and end users, are to enjoy the best tooling economy in their production. In these times when escalating production costs cannot always be covered by increased prices, then getting the most out of tooling is often a vital ingredient in attaining viable production economy.



## UDDEHOLM HOT WORK TOOL STEELS FOR DIES AND EXTRUSION TOOLING

Uddeholm hot work tool steel for the manufacture of tools and components in extrusion presses:

Uddeholm Impax Supreme

Uddeholm Alvar 14

Uddeholm Orvar 2 Microdized

Uddeholm Vidar 1

Uddeholm QRO 90 Supreme

Uddeholm Formvar

Uddeholm Dievar

Uddeholm Unimax

The steel grades have different characteristics suitable for:

- mandrels
  - mandrel holders
  - stems
  - dummy blocks
  - liners
  - intermediate liners
  - mantles
  - dies
  - die rings
  - bolsters
  - wedge blocks
- } containers



Uddeholm have long experience in producing hot work tool steel for dies and extrusion tooling components. The demands on the tool steel depend on the overall working temperature, i.e. on the metal being extruded, and on the location of the component in question in relation to the hot billet and the emerging extruded profile. The component which is subjected to the most severe thermal influence and which is also most highly stressed is, of course, the die. Other parts which experience high temperatures are the liner, dummy block and, in the cases where one is used, the mandrel.

The typical temperature ranges experienced by these components during extrusion are:

- aluminium and its alloys: 400–600°C (750–1110°F)
- copper and copper alloys: 600–1000°C (1110–1830°F)
- Steel: 1100–1250°C (2010–2280°F)

An optimum choice of tool steel and correct heat treatment are essential in order to increase the life of extrusion dies and extrusion tooling components which are subjected to these severe thermal conditions.

# TOOL STEEL PROPERTIES FOR EXTRUSION DIES AND TOOLING

The properties profile required for the tool steel in different components of an extrusion press is fairly similar. However, the varying severity of the thermal environment means that the desirable heat-resisting properties of hot work tool steel are required to greater or lesser extent in different press parts. The requisite properties profile is essentially as follows:

- adequate resistance to wear at elevated temperatures (e.g. dies, liners, mandrels)
- enhanced hot yield strength and hot hardness
- high level of temper resistance and resistance to softening at elevated temperatures
- good compressive strength (e.g. dummy blocks and stems) and bending strength (e.g. dies, mandrels) at high temperatures
- high creep strength
- acceptable resistance to thermal fatigue cracking

Uddeholm's tool steel product programme for extrusion dies and extrusion tooling components is presented at the end of this brochure.

For press components and dies subjected to the highest temperature, we recommend:

- Uddeholm Orvar 2 Microdized
- Uddeholm Vidar 1
- Uddeholm QRO 90 Supreme
- Uddeholm Formvar
- Uddeholm Dievar
- Uddeholm Unimax

In general Uddeholm Orvar 2 Microdized and Uddeholm Vidar 1 are used in normal applications involving moderate temperatures and stresses, e.g. dies and other tooling components for production of standard aluminium profiles.

For more extreme conditions Uddeholm QRO 90 Supreme, Uddeholm Formvar, Uddeholm Dievar and Uddeholm Unimax are recommended; these are speciality grades characterized by an extreme combination of toughness, ductility and strength at elevated temperatures.

## TEMPER RESISTANCE

Temper resistance can be assessed from the tempering curve for a hardened tool steel. In this, the hardness at room temperature is plotted against tempering temperature for given tempering time. Another method of presenting temper resistance data is to plot room temperature hardness against time at a given tempering temperature. The better the steel retains its hardness as the temperature or the time increases, the better its temper resistance,

## HOT STRENGTH AND HOT HARDNESS

In contrast to temper resistance, which is defined in terms of hardness at room temperature, hot strength and hot hardness refer to properties at high temperature. In general, improved temper resistance is associated with increased hot strength and hot hardness. It can be pointed out that good hot hardness and hot strength are important prerequisites for enhanced wear resistance at elevated temperatures. A high level of hot hardness and hot strength is also important in order to achieve adequate resistance to thermal fatigue cracking.

## COMPRESSIVE STRENGTH AND BEND STRENGTH AT HIGH TEMPERATURE

The greater the level of hot strength or hot hardness for a tool steel the greater is its elevated

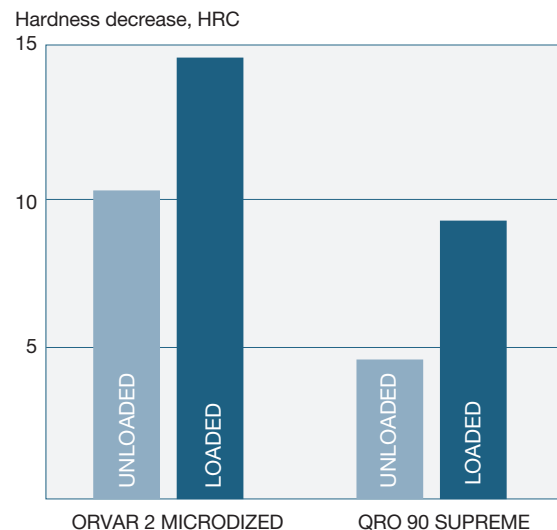


Fig. 1. Hardness drop after 24 hours at 600°C (1110°F) during compression.

temperature bend strength and compressive strength. The improved hot compressive strength is reflected in figure 1, which shows the drop in hardness from a given initial hardness, over 24 h for Uddeholm Orvar 2 Microdized and Uddeholm QRO 90 Supreme loaded in compression at 600°C (1110°F). It is clear, from comparison with the hardness decrease in the unloaded condition, that the mechanical stress accelerates the softening of the steel. Uddeholm QRO 90 Supreme retains the same degree of superiority over Uddeholm Orvar 2 Microdized irrespective of whether the steel is subjected to mechanical loading or not during holding at high temperature.

The high temperature bend strength is influenced by, apart from hot hardness, the toughness and ductility of the steel.

### DUCTILITY AND TOUGHNESS

The ductility of a die material quantifies the ability to resist plastic strain without cracking and is greatly influenced by the purity and the homogeneity of the material.

The toughness of the die material is the ability to resist loading without cracking at sharp notches or other stress raisers. The toughness depends on the die material and its heat treatment.

Uddeholm tool steel are manufactured to a very high degree of purity with regard to non-metallic inclusions. This ensures a level of toughness and ductility which is adequate for even the most exacting applications in extrusion, e.g. where dies and other tooling components are subjected to severe bending stresses at elevated temperature.

### CREEP STRENGTH

Creep is the slow, time dependent deformation of a metal subjected to loading at a level below what is normally required to plastically deform the metal at the temperature in question. A good creep strength improves the resistance to fracture at high temperatures and long time dependent loading.

Figure 2 demonstrates the qualitative comparison of critical steel properties and figure 3 the resistance to different failures.

UDDEHOLM TOOL STEEL	CREEP STRENGTH			
	TEMPER RESISTANCE	HOT STRENGTH HOT HARDNESS	COMPRESSIVE STRENGTH	DUCTILITY TOUGHNESS
ORVAR 2 M	██████	██████	██████	██████
VIDAR 1	██████	██████	██████	██████
QRO 90 SUP	████████	████████	████████	██████
FORMVAR	██████	██████	██████	██████
DIEVAR	██████	██████	██████	████████
UNIMAX	██████	██████	██████	██████

Fig. 2. Qualitative comparison of critical steel properties (the longer the bar, the better).

UDDEHOLM TOOL STEEL	RESISTANCE TO FAILURES			
	HOT WEAR	PLASTIC DEFORMATION	PREMATURE CRACKING	HEAT CHECKING
ORVAR 2 M	██████	██████	██████	██████
VIDAR 1	██████	██████	██████	██████
QRO 90 SUP	████████	████████	██████	████████
FORMVAR	██████	██████	██████	████████
DIEVAR	██████	██████	████████	██████
UNIMAX	████████	████████	████████	████████

Fig. 3. Qualitative comparison of resistance to different tool failures (the longer the bar, the better).

# MATERIAL SELECTION FOR DIES AND EXTRUSION TOOLING PARTS

## EXTRUSION DIES

An extrusion die is exposed to high temperatures derived not only from the heated billet but also from heat generated by deformation and friction. In addition, the die is subjected to high pressure and, in the area of the die land, considerable frictional forces. In aluminium extrusions, the hard oxide film, which forms instantaneously on the surface of the extruded metal, causes extensive abrasion of the die during service.

## DIE DESIGN

The die design and manufacture of extrusion dies is a highly specialized procedure requiring skilled die makers. It is necessary at the design stage to make proper allowance for shrinkage, elastic deformation, the nature of the profile section and the highly uneven velocity distribution when extruding complicated profiles (so that the profile remains more or less straight when extruded).

The following criteria should be fulfilled during die design and manufacture:

- very tight tolerances, so that the extruded profile does not have excessive weight per unit length (material yield)
- correct die geometry from the beginning, thereby avoiding expensive reworking
- carefully finished land surface such that the profile surface is acceptable
- proper design, choice of die steel, heat treatment etc., giving maximum die life
- rational production resulting in low die manufacturing costs

## FACTORS DETERMINING DIE LIFE

The stresses experienced by an extrusion die in service are both mechanical and thermal in origin. However, the thermal stresses arising from temperature differences are generally quite moderate in extrusion, where the temperature changes occur only fairly slowly. Hence, thermal fatigue cracks develop less gradually in extrusion than in other presses where hot work steel are

used and where the temperature cycles are much more severe e.g. die casting. On the other hand, wear is very pronounced in extrusion, since the process involves sliding contact between the die steel and the metal being extruded. Die life is therefore finite and is limited by (in order of importance):

- wear
- plastic deformation or cracking
- indentation
- stability of support tooling
- formation of thermal fatigue cracks

The second point above deserves comment. Plastic deformation or even cracking of dies can occur particularly when extruding very complicated profiles through dies with high tongue ratios. In this case, the very great stress on the tongue combined with the locally high temperature can cause bending; in some instances, the tongue can actually break off if the transverse toughness of the steel is inadequate.

A tool steel with good hot strength and sufficient transverse toughness is a must for dies with high tongue ratios.

## IMPROVEMENT OF WEAR RESISTANCE

Hot work tool steel are amenable to nitriding which produces a hard, wear-resistant surface layer. Nitriding is usually effected via salt-bath treatment, e.g. Tufftriding, and a given extrusion die can be treated many times until it is considered worn out. Nitriding of extrusion dies not only improves wear resistance but also reduces friction.

In the context of wear resistance, the temper resistance, hot strength and hot hardness of the steel are all important. In the region of contact between die and extruded metal, considerable deformational and frictional heat is developed and high temperatures are experienced. Appreciable wear will thus result if the temperature become so high that the surface of the die steel in the land region softens extensively. In the case of a nitrided die, the underlying steel can not, under such circumstances, give proper support to the nitrided layer which will wear more rapidly than usual.



## TOOL STEEL SELECTION FOR DIES

Standard dies for aluminium extrusion are made from Uddeholm Orvar 2 Microdized and Uddeholm Vidar 1, heat treated to 45–50 HRC and then nitrided/nitrocarburized, usually via tufftriding or some similar treatment. The nitrid-ed layer is up to 0.1 mm (0.004 inch) thick and has a surface hardness exceeding 1000 HV.

For pressing high strength aircraft alloys, it is important that the die material exhibits adequate transverse toughness in view of the very high pressures required for extrusion, which can otherwise be sufficient to fracture the die.

For dies with high tongue ratios and for producing complicated profiles, using Uddeholm QRO 90 Supreme will usually result in considerably better life than W.-Nr. 1.2344 (AISI H13 type) steel even for aluminium extrusion. Such dies are characterized by excessive heat generation in the land area and the superior hot strength/hot hardness of Uddeholm QRO 90 Supreme engenders enhanced resistance to wear and bending/breakage. Practice has shown that Uddeholm QRO 90 Supreme can be used for tongue ratios up to 6:1 whereas W.-Nr. 1.2344 (AISI H13 type) steel is limited to about 3:1 maximum. In addition, the superior wear resistance of Uddeholm QRO 90 Supreme renders it eminently suitable for long run aluminium dies.

Uddeholm QRO 90 Supreme is also recommended for less complicated dies in extrusion of copper alloys and other metals and alloys, which are extruded at higher temperatures than aluminium.

Uddeholm Formvar is a high performance hot work tool steel when good temper resistance is needed to maintain hardness.

Uddeholm Dievar is a hot work tool steel suitable when premature cracks and heat checking are the dominating failure mechanisms. Also, in combination with other failure mechanisms as hot wear and plastic deformation Uddeholm Dievar offers potential solutions for an improved tooling economy.

Uddeholm Unimax is an updated Dievar quality and can be hardened to 57–58 HRC giving a good combination of hot wear and toughness.

## STEMS

Stems are subjected to high pressure during extrusion but their working temperature is relatively low (not in contact with billet). A stem should not bend or otherwise deform at the temperature of operation.

Uddeholm Orvar 2 Microdized is a suitable tool steel for stems (46–50 HRC), independent of what material is to be extruded.



## DUMMY BLOCKS

The dummy block physically separates the stem from the billet and, as such, has two basic functions:

- to protect the stem
- to prevent backwards “leakage” of the metal being extruded

Exchangeable dummy blocks have been used for many years in all types of extrusion applications. The disc-like dummy block is changed after each billet and a number of blocks are kept in circulation. For extrusion of copper, copper alloys and steel, an exchangeable dummy block is always used (high temperature, dummy block must cool between billets). However, the fixed dummy block has become standard for aluminium extrusion. This comprises two parts, a “male” and a “female”; the male is coupled to the female which in turn is fixed to the stem. Fixed dummy blocks are not changed between billets.

The fixed type of dummy block has the advantages of:

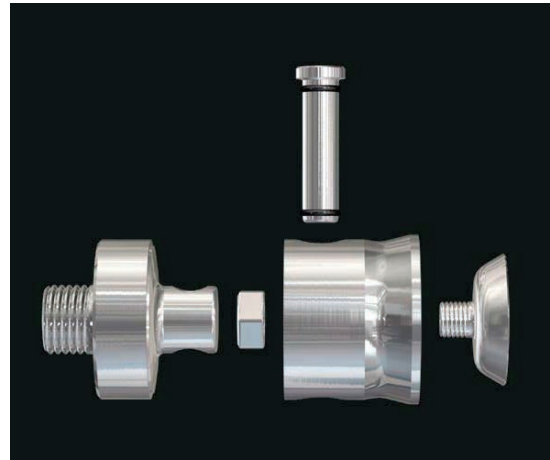
- improved productivity
- better yield
- superior surface finish of the extruded profile

Since both types of dummy block are subjected simultaneously to high pressure and temperature, the tool steel used for these components is required to exhibit:

- high level of hot strength/hot hardness
- good temper resistance
- good resistance to plastic deformation via creep

Uddeholm Orvar 2 Microdized is recommended for both exchangeable and fixed dummy blocks in all extrusion applications. Also Uddeholm Dievar and Uddeholm QRO 90 Supreme can be used for dummy blocks.

One important function of the dummy block is to expand more or less elastically during the forward part of the cycle so as to tighten against the liner and prevent backward metal leakage. It is important that the yield stress of the steel is not exceeded during the expansion phase resulting in plastic deformation. High forces would be required to release the dummy block on its return phase, increasing the risk of movement in the liner. The relevant stress-strain curve is that at the



actual working temperature of the dummy block. Hence, the better the hot yield strength of the tool steel, the better the chance of not exceeding the elastic limit during service and the lower the risk for permanent deformation of the dummy block. In a similar vein, the dummy block should not creep excessively during service, i.e. should exhibit as little slow, permanent deformation as possible at loads below the elastic limit.



## MANDRELS

Mandrels normally find application for extrusion of steel and copper tube.

Mandrels are subjected to severe operating conditions and the tool steel used to make them should possess:

- high strength at elevated temperatures
- good temper resistance

i.e. the same properties profile as for dummy blocks. For thin mandrels, resistance to bending at elevated temperatures is important. Hence, Uddeholm QRO 90 Supreme will give superior mandrel life in most applications. When internal cooling is used Uddeholm Dievar, because of its good ductility and toughness, can be recommended.

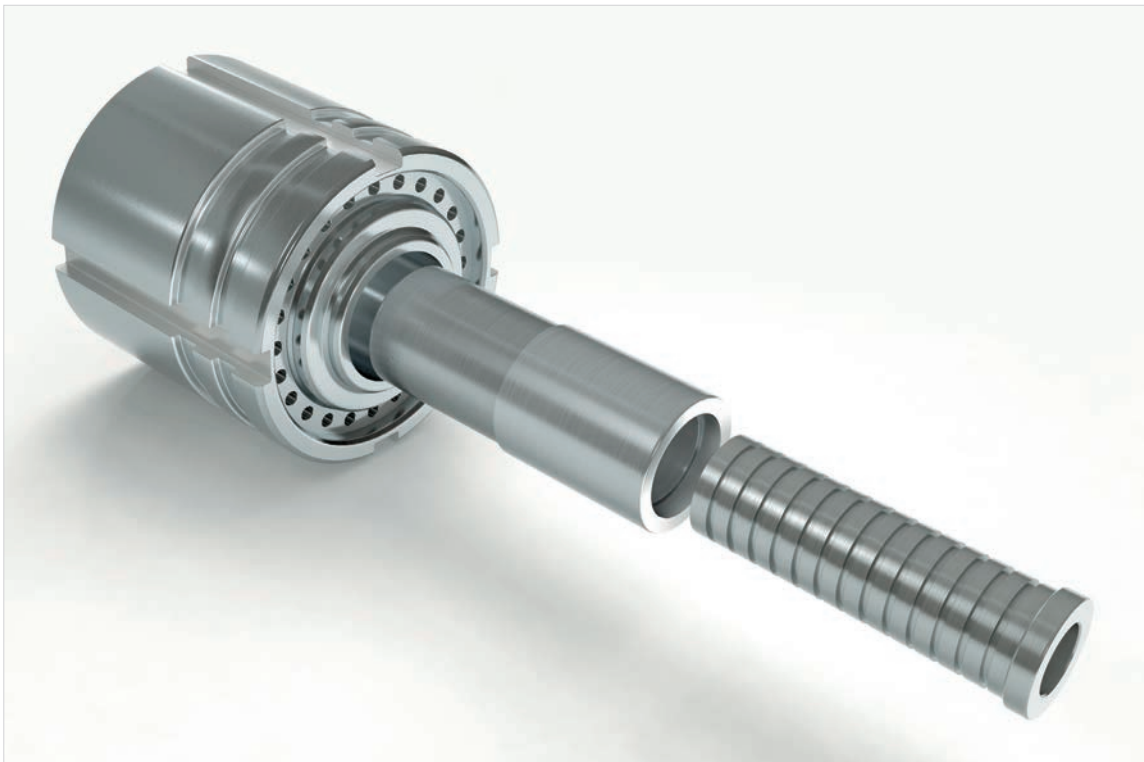
## CONTAINERS

Containers can be built in two or three parts.

A two-part container consists of a mantle and a liner, while a three-part one comprises a mantle, an intermediate liner and a liner proper.

The function of the container is to take up the hydrostatic and tangential stresses derived from the extrusion force. Nowhere in the container should these stresses exceed the elastic limit, i.e. the working stress range is similar to that for a dummy block with the qualification that the liner and the mantle are at different temperatures and will thus be characterized by different stress-strain curves.

If the elastic limit is exceeded for the steel in the mantle, the whole container will deform plastically to an extent that it may go out of tolerance. In extreme loading situation, it is not infeasible that the entire container can crack. Containers subjected to heavy loads are thus normally built in three parts. While this is obviously more expensive, it does give the advantage that the stress levels in each individual part are reduced appreciably at a given extrusion pressure, when compared with a two-part container.



## MANTLE

Prehardened tool steel such as Uddeholm Impax Supreme can be used for a low-stressed container mantle (hardness approx. 310 HB).

For highly-stressed containers, Uddeholm Orvar 2 Microdized at 37–43 HRC is a better choice. Compared with prehardened, quenched-and-tempered steel, Uddeholm Orvar 2 Microdized exhibits superior temper resistance and hot strength. With Uddeholm Orvar 2 Microdized as mantle material, there is virtually no chance of the mantle softening during service to the extent that the whole container suffers permanent deformation.

## INTERMEDIATE LINER

The intermediate liner, when one is used, is normally made in Uddeholm Orvar 2 Microdized, 37–43 HRC.

## LINER

Uddeholm Orvar 2 Microdized or Uddeholm Vidar 1 hardened and tempered to 44–48 HRC is normally used as a liner material in aluminium extrusion. For more difficult aluminium alloys, Uddeholm QRO 90 Supreme is recommended.

## SUPPORTING TOOLS

The die is positioned in a die ring, which in turn is attached to and is supported by one or more holder parts such as die rings, bolsters, wedge blocks etc. No problems are normally encountered with these parts in the extrusion of simple profiles; for more complicated shapes, however, it can be difficult to arrange for adequate support for the die. If there is any risk for overloading of the support tooling, it is important to select a tool steel with adequate hardness at the working temperature. In general, Uddeholm Orvar 2 Microdized is used for die rings and Uddeholm Alvar 14 for bolsters. Other support tools such as wedge blocks and die heads can, as long as the service temperature is low, be made in prehardened Uddeholm Impax Supreme.

# MANUFACTURING OF DIES AND TOOLING

The machinability and heat treatment characteristics of the tool steel are significant parameters influencing the relative ease of manufacture of extrusion dies and extrusion tooling components.

## MACHINABILITY

Uddeholm hot work tool steel; Orvar 2 Microdized, Vidar 1, QRO 90 Supreme and Hotvar are characterized by a high degree of freedom from oxide inclusions and an annealed microstructure consisting of a very even distribution of small carbides. The annealed hardness is low, 180–210 HB. These features are concomitant with a good machinability in the annealed condition. Advanced process control ensures that the variation in machining characteristics is minimal from batch to batch.

Uddeholm Dievar's and Uddeholm Unimax's extreme microcleanliness and special chemical composition make the machinability less competitive compared to the steel mentioned above.

Our product information brochures for Uddeholm Orvar 2 Microdized, Uddeholm QRO 90 Supreme, Uddeholm Formvar and Uddeholm Dievar give detailed information pertaining to machining of these products. Other Uddeholm brochures worth consulting in the context of die/tooling manufacture are: "Grinding of Tool Steel", "EDM (spark-erosion) of Tool Steel" and "Welding of Tool Steel".

## HEAT TREATMENT

Hot work tool steel used for extrusion dies and tooling are normally supplied in the annealed condition. After machining, the tool/die must be heat treated in order that the steel develops its optimum combination of hardness, toughness and heat resistance. These properties are controlled through proper choice of austenitizing temperature, cooling conditions during hardening and tempering temperature/time.

More information is given in the product brochures and in the treatment brochure "Heat treatment of Tool Steel".



# TOOL STEEL PRODUCT PROGRAMME FOR EXTRUSION INDUSTRY

## GENERAL DESCRIPTION

<p><b>UDDEHOLM TOOL STEEL</b></p> <p>ORVAR 2 MICRODIZED W.-Nr. 1.2344 (AISI H13)</p>	<p>A Cr-Mo-V-alloyed hot-work steel with good high temperature strength and good resistance to abrasion. Recommended in most cases for tooling components and dies in aluminium extrusion which come into direct contact with the hot billet.</p>
<p>VIDAR 1 W.-Nr. 1.2343 (AISI H11)</p>	<p>A Cr-Mo-V-alloyed hot-work steel with good combination of high temperature strength, good toughness and good resistance to abrasion.</p>
<p>QRO 90 SUPREME</p>	<p>A premium hot work steel with very good strength and hot hardness at elevated temperatures. Recommended for dies and all types of extrusion tooling subjected to maximum working temperatures.</p>
<p>FORMVAR</p>	<p>A high performance hot work tool steel with very good resistance to hot wear and plastic deformation.</p>
<p>DIEVAR</p>	<p>A premium Cr-Mo-V hot work steel with good high temperature strength and excellent toughness and ductility in all directions. Recommended in dies and extrusion components where the demands on toughness and ductility are the highest.</p>
<p>UNIMAX</p>	<p>A premium Cr-Mo-V alloyed steel with a good toughness and ductility up to a hardness of 58 HRC.</p>
<p>ALVAR 14 W.-Nr. 1.2714</p>	<p>Cr-Ni-Mo-alloyed hot work steel. Recommended for support tooling in extrusion, e.g. bolsters and wedge blocks.</p>
<p>IMPAX SUPREME W.-Nr. 1.2738 (AISI P20)</p>	<p>Prehardened Ni-Cr-Mo-alloyed steel supplied at approx. 310 HB, with good machinability. Suitable for wedge blocks and other support tools, mantles and intermediate liners, at lower temperature.</p>

## CHEMICAL COMPOSITION

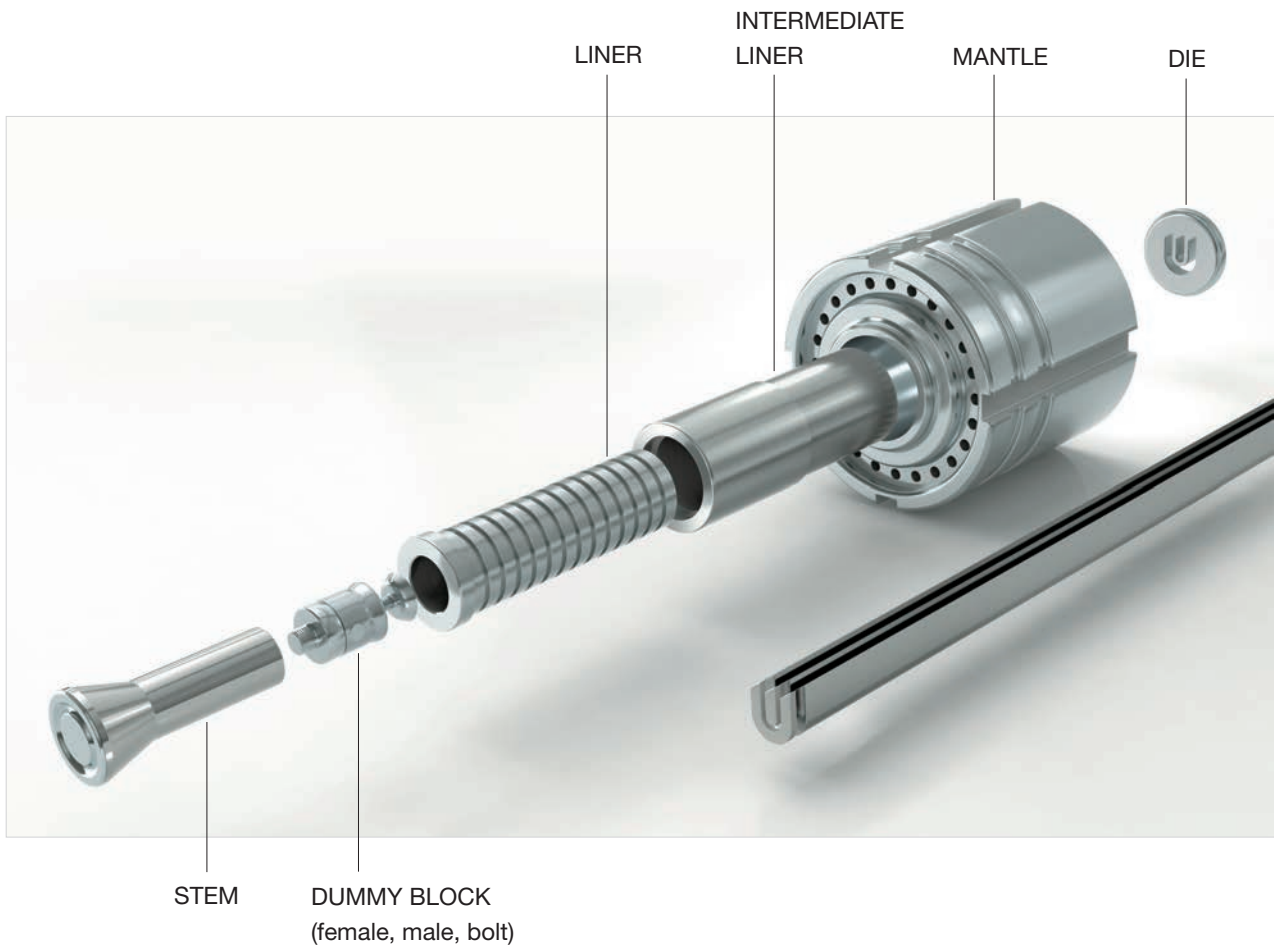
UDDEHOLM TOOL STEEL	AISI	C	ANALYSIS %						DELIVERY HARDNESS Brinell
			Si	Mn	Cr	Mo	V	Ni	
ORVAR 2 MICRODIZED	H13 (W.-Nr. 1.2344)	0.39	1.0	0.4	5.3	1.3	0.9	–	Annealed ~180
VIDAR 1	H11 (W.-Nr. 1.2343)	0.38	1.0	0.4	5.0	1.3	0.4	–	Annealed ~180
QRO 90 SUPREME	–	0.38	0.3	0.8	2.6	2.3	0.9	–	Annealed ~180
FORMVAR	–	0.35	0.2	0.5	5.0	2.3	0.6	–	Annealed <229
DIEVAR	–	0.35	0.2	0.5	5.0	2.3	0.6	–	Annealed ~160
UNIMAX	–	0.50	0.2	0.5	5.0	2.3	0.5	–	Annealed <185
ALVAR 14	(W.-Nr. 1.2714)	0.55	0.3	0.7	1.1	0.5	0.1	1.7	Annealed ≤250
IMPAX SUPREME	P20 (W.-Nr. 1.2738)	0.37	0.3	1.4	2.0	0.2	–	1.0	Prehardened ~310

## STEEL AND HARDNESS SELECTION FOR DIFFERENT EXTRUSION APPLICATIONS

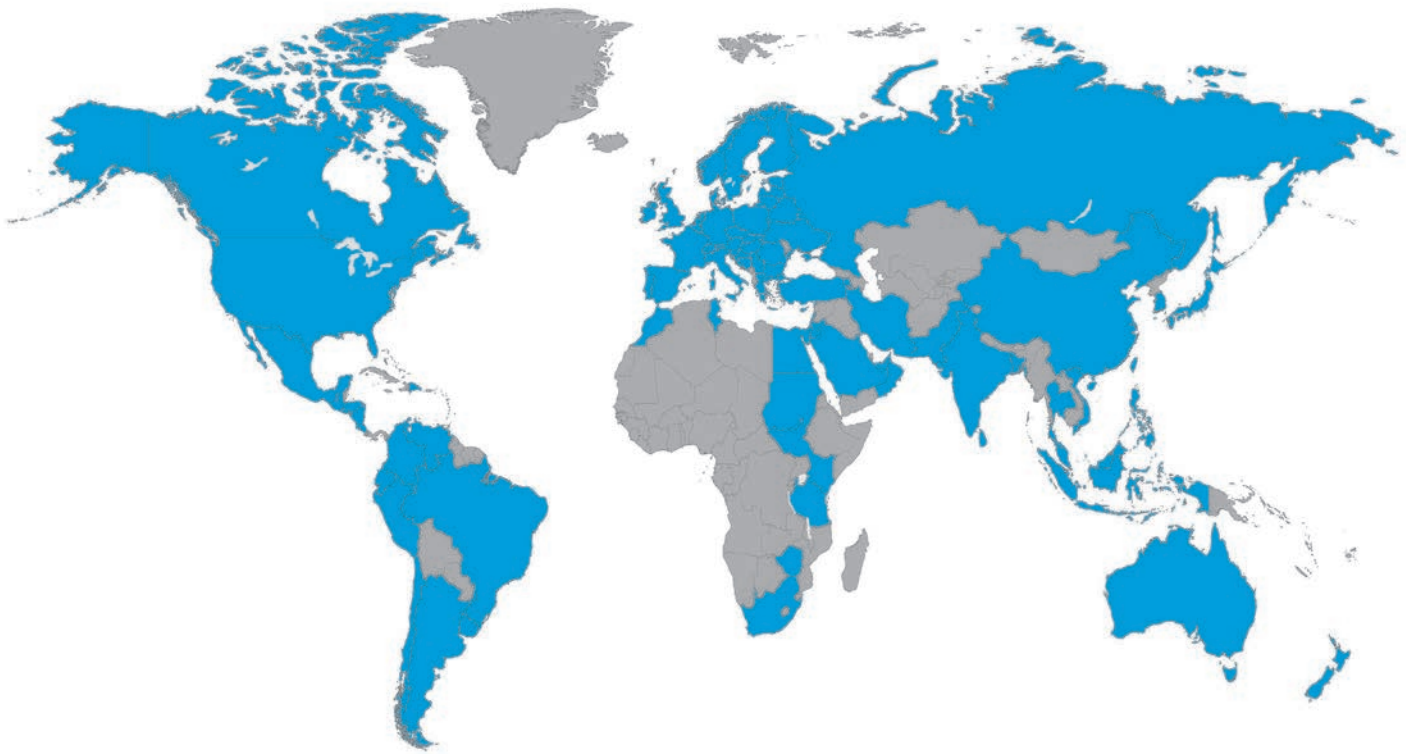
TOOLING COMPONENT	EXTRUDED MATERIAL		
	ALUMINIUM/MAGNESIUM	COPPER ALLOYS	STEEL
SUPPORT TOOLS (at lower temp.)	IMPAX SUPREME ~310 HB	IMPAX SUPREME ~310 HB	IMPAX SUPREME ~310 HB
WEDGE BLOCK	IMPAX SUPREME ~310 HB ALVAR 14 300–400 HB	IMPAX SUPREME ~310 HB ALVAR 14 300–400 HB	IMPAX SUPREME ~310 HB ALVAR 14 300–400 HB
BOLSTER	ALVAR 14 ~45 HRC	ALVAR 14 ~45 HRC	ALVAR 14 ~45 HRC
DIE RING	FORMVAR ORVAR 2 MICRODIZED 40–44 HRC	QRO 90 SUPREME 40–44 HRC	QRO 90 SUPREME 40–44 HRC
DIE	FORMVAR VIDAR 1 ORVAR 2 MICRODIZED QRO 90 SUPREME 45–50 HRC DIEVAR 46–52 HRC UNIMAX 52–58 HRC	QRO 90 SUPREME 45–49 HRC	QRO 90 SUPREME 44–46 HRC
MANTLE INTERMEDIATE LINER	IMPAX SUPREME ~310 HB ORVAR 2 MICRODIZED 37–43 HRC VIDAR 1 37–43 HRC	IMPAX SUPREME ~310 HB ORVAR 2 MICRODIZED 37–43 HRC	IMPAX SUPREME ~310 HB ORVAR 2 MICRODIZED 37–43 HRC
LINER	ORVAR 2 MICRODIZED QRO 90 SUPREME VIDAR 1 44–48 HRC DIEVAR 44–50 HRC	QRO 90 SUPREME 44–48 HRC	ORVAR 2 MICRODIZED 44–48 HRC
DUMMY BLOCK	QRO 90 SUPREME 44–48 HRC DIEVAR 46–52 HRC ORVAR 2 MICRODIZED 46–50 HRC	QRO 90 SUPREME 44–48 HRC	QRO 90 SUPREME 44–48 HRC



TOOLING COMPONENT	EXTRUDED MATERIAL		
	ALUMINIUM/MAGNESIUM	COPPER ALLOYS	STEEL
FASTENERS FOR FIXED DUMMY BLOCK	IMPAX SUPREME ~310 HB		
STEM	ORVAR 2 MICRODIZED 46-50 HRC	ORVAR 2 MICRODIZED 46-50 HRC	ORVAR 2 MICRODIZED 46-50 HRC
MANDREL	ORVAR 2 MICRODIZED 46-50 HRC QRO 90 SUPREME 46-49 HRC	QRO 90 SUPREME 45-49 HRC DIEVAR 46-52 HRC	QRO 90 SUPREME 45-49 HRC







## **NETWORK OF EXCELLENCE**

Uddeholm is present on every continent. This ensures you high-quality Swedish tool steel and local support wherever you are. We secure our position as the world's leading supplier of tooling materials.

Uddeholm is the world's leading supplier of tooling materials. This is a position we have reached by improving our customers' everyday business. Long tradition combined with research and product development equips Uddeholm to solve any tooling problem that may arise. It is a challenging process, but the goal is clear – to be your number one partner and tool steel provider.

Our presence on every continent guarantees you the same high quality wherever you are. We act worldwide. For us it is all a matter of trust – in long-term partnerships as well as in developing new products.

For more information, please visit [www.uddeholm.com](http://www.uddeholm.com)