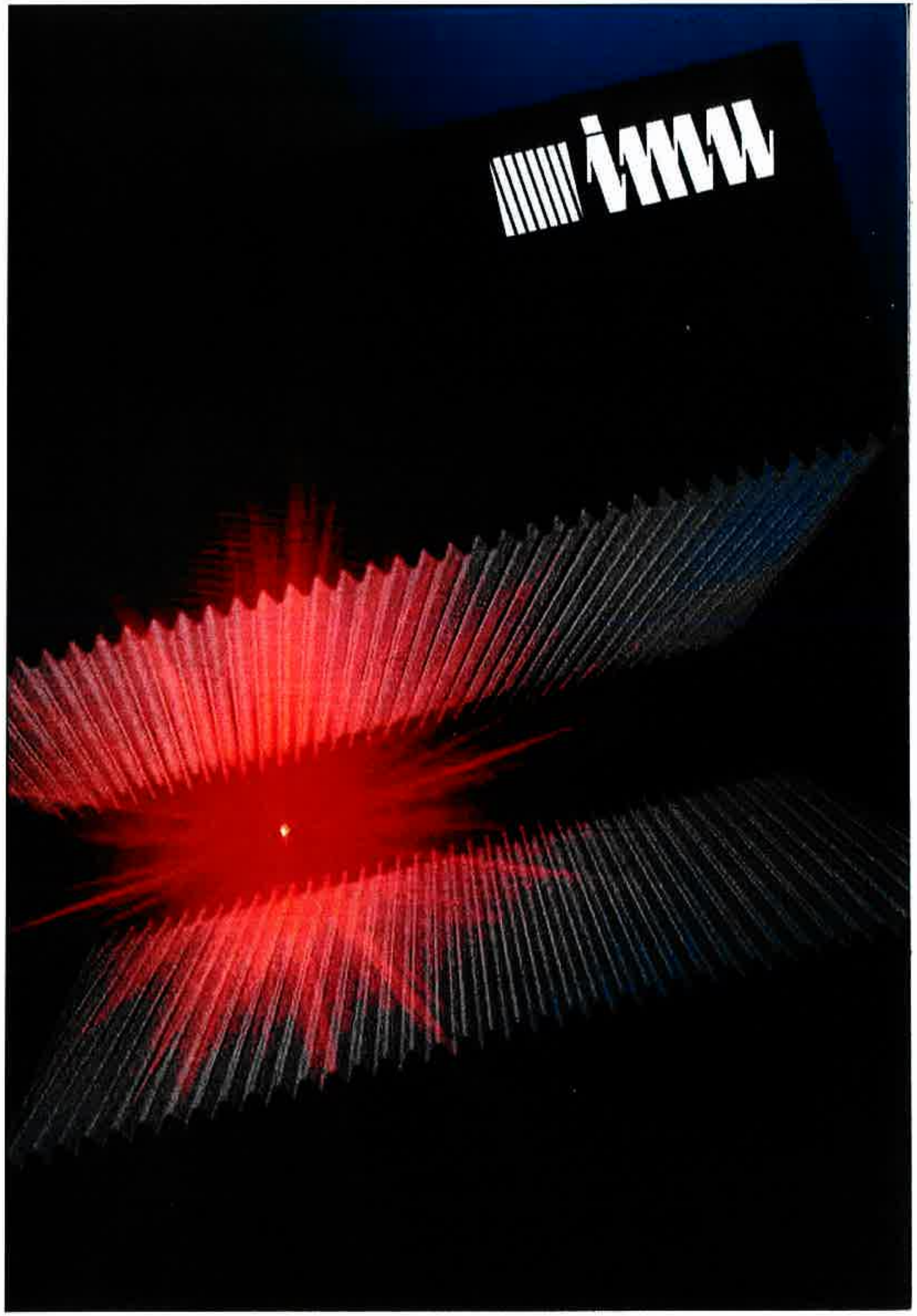


COMPANY PROFILE

IMU exclusively manufactures and stocks coated high speed steel flat thread-roll dies for machine screws.

Dies are manufactured in Milan, Italy, by I.M.U. sas.
I.M.U. sas was founded in 1924 as a tap manufacturing facility, started production of thread rolling dies in 1977 after having gradually abandoned taps.

I.M.U. sas acquired ISO 9002 certification in July 1999 and ISO 9001:2000 certification in May 2003. Its 30,000 sq. ft. plants host a full in-line manufacturing process. Computerized control of production & quality as well as extensive CNC grinding capabilities are major features of IMU. Quality & testing departments are supported by research programs constantly aiming at upgrading die quality.

IMU dies are sold & stocked worldwide. Large permanent IMU die stocks are located in the United States, Taiwan, France, Germany & Sweden.

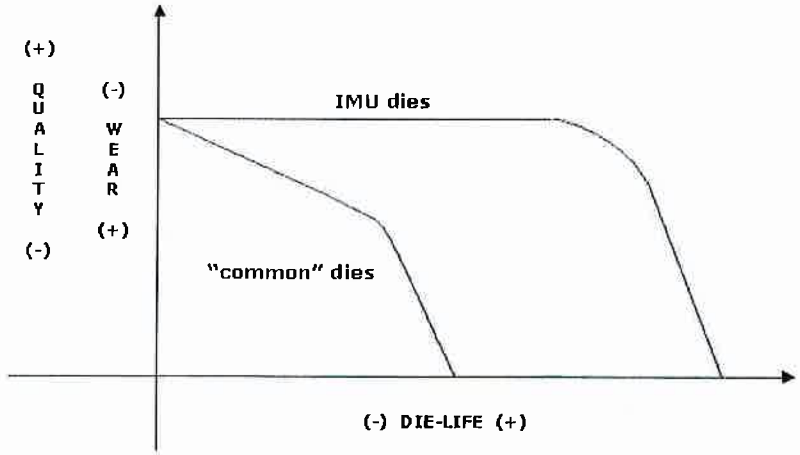
DIE FEATURES

HIGH SPEED STEEL DIES: WHY?

Before analyzing the different die-versions IMU offers to its customers, it is worthwhile to touch on several reasons why IMU has committed itself to exclusively manufacturing high speed steel dies (as opposed to popular tool steels, such as AISI D2).
In a word, high speed steel dies yield far better die-life than "common" tool steels. Enhanced die-life implies:

1) Greater consistency of the quality of the rolled parts.
On "common" (D2) dies, wear leads to a gradual and progressive modification of the geometry of the thread profile. This modification is observed on the thread crests which typically appear flat, as opposed to their radiused form. As a result, the internal thread radii of the rolled parts increase and thread depth decreases. Thus, parts rolled when the dies are still new normally carry a different thread profile when compared to parts rolled just before replacing the dies. At the same time, wear on "common dies" brings to a pronounced coarseness of the surface of the thread crests. This coarseness primarily affects the surface finish of the bottom portion of the thread of the rolled parts.
Parts rolled with IMU dies maintain consistency throughout nearly all of the dies' useful life. Dimensional inconsistency and poor surface finish appear only towards the very end.

The figure below illustrates a typical die-life / wear curve of IMU dies, as opposed to that of "common" dies. Quality is considered here in terms of dimensional consistency and good surface finish.



2) Less frequency in die change.
The longer life of IMU dies reduces the number of die changes taking place every time worn dies have to be replaced. Reduction in down-time is the result.

3) "Re-grindability".
Die-users sometimes remark that "dies just don't hold up after re-grinding" and proceed to tell of 40% to 50% reductions in die-life as compared to figures achieved by new dies. This may hold true for certain types of "common dies". By the time any dies reach the end of their useful life they have accumulated stress tensions which the re-grinding operation by itself will not eliminate. Moreover, some brands of "common dies" are not core-hardened: the hardened structure below the threaded surface may not have undergone a complete structural transformation during heat treatment.
High speed steel lends itself very well to stress-relieving operations and various coatings. In addition, the heat treatment process applied to IMU dies guarantees a consistent structure throughout the whole die section. These factors guarantee consistently identical performance between new & re-ground IMU dies.

4) Lower percentage of die cost on the cost of the rolled screw.
Even if a set of IMU dies is more expensive than a set of "common dies", the greater quantity of screws rolled with the set of IMU dies more than makes up the difference with a reduced cost per part.

The main reason die-users give for resisting the move to high speed steel dies is brittleness: D2 dies are considered tougher, and thus more forgiving when operator set-up & threadroller conditions are not under full control.
While there is a kernel of truth in this, IMU has designed its dies by dedicating special attention to the heat treatment process in order to achieve greater toughness without sacrificing wear resistance. Therefore, IMU dies can be safely used in any application (obviously, a proper die set-up procedure is always required - see our section on set-up) .

IMU DIE VERSIONS

IMU offers 2 different die versions: Standard & Superdie.

These 2 versions differ in respect to employed high speed steel, heat treatment and coating. There is no difference in geometrical accuracy between the 2 versions. Eventual requirements of special tolerances on dies are dealt with in the "tolerances" section.
To simplify, Standard dies are defined as those which are AISI M2-coated and Superdies, those which are AISI M42-coated. Different variations of these two basic versions are offered, usually depending on customer application or - at times - on die-upgrades dictated by IMU's intensive research program. Some IMU dies, for example, may be marked or labelled "Superdie 1" or "Superdie 2" in reference to metallurgical specifications which pertain only to that die variation. Material type, hardness and tensile strength of the rolled blank determine whether Standard dies or Superdies should be employed.

STANDARD

IMU does not purchase steel from just any source; it provides its own specifications by which a designated vendor must manufacture the steel. Standard dies are built out of AISI M2 steel manufactured to IMU specifications. IMU performs heat treatment & coating "in-house" following proprietary procedures which undergo continuous refinement. Standard dies are typically offered with average hardness of 64.5 HRC.

Standard dies are suggested on the following applications:

- long runs of low-carbon parts (not heat treated)
- stainless steel 300 & 400 series not exceeding 120,000 psi tensile strength
- alloys or heat treated parts not exceeding 36 HRC hardness

SUPERDIE

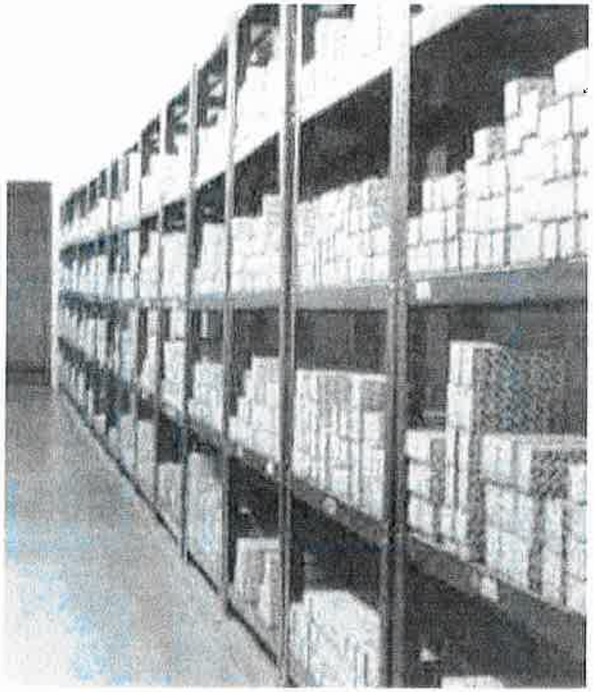
The Superdie is the result of IMU' s most advanced technology. The intensive research program behind the Superdie is driven by the need to roll the toughest alloys or hardened parts above the upper 30 HRCs. This challenge is brought by fasteners designed for aircraft applications as well as those for certain automotive & hi-tech applications.
Superdies are built out of AISI M42 steel manufactured to IMU specifications. Special heat treatment procedures and coatings are applied; both are subject to constant development, thus giving birth to different generations of Superdies. Two conditions determine whether these developmental updates are applied to Superdies carried in general stock: consistency of the manufacturing process and customer feedback. Both are based on a significant amount of tests.
Superdies are typically offered with average hardness of 67.5 HRC. Superdies are recommended for the following applications:

- materials for aircraft applications (for example, Titanium, A-286, 8740, 4047, Waspalloy, Inconel)
- virtually any parts exceeding a hardness of 36 HRC

This graph shows how the Superdie out-performs the Standard die as the rolled parts get harder. Figures below are based on tests with M10x1.25 heat treated parts rolled with Waterbury 30, 50 mms single face dies, boltmaker lead.

Hardness of rolled parts	*Standard Version (pcs / edge)*	*Superdie (pcs / edge)*	*Difference in Die-life (Superdie vs. Standard)*
32 HRC	75,000	90,000	+ 20%
38 HRC	40,000	60,000	+ 50%
42 HRC	20,000	35,000	+ 75%

STOCK PROGRAM



Permanent IMU die stocks worldwide are designed to the ma-nufacturing specs. typically requested by the local cust-omers.

Additionally, IMU designs and stocks dies according to individual customer require-ments.

Thus, every IMU stock program is twofold:

1) providing a wide range of the most common die-sizes and threads required by the market serviced;

2) maintaining stocks design-ed to individual customers and constantly updating each sin-gle customer on status of in-ventory.

All this brings to a "flexible stock" concept, where the customer advises which die-sizes and versions are suitable.

Single face single-entrance, single face double-entrance, duplex, split face, boltmaker dies...... virtually any die is manufactured and stocked by IMU.

DIE-LIFE

At first glance, die-life appears unpredictable given the number of variables involved.
While exact prediction still remains impossible, we can provide fairly accurate die-life figures for most applications in which our dies are employed thanks to an extensive die-life data bank. IMU stores any significant die-life data submitted by its customers; constantly updated information is crucial to the development of the proper dies for each specific application.

The aim of this chapter is not to provide hard statistical data for all examined cases, but to give general information on the most important variables which determine die-life on machine screw thread applications.

Die-life is the result of three factors, namely:

1. the fastener
2. the machine
3. the dies

In this case, the term "fastener" stands for a general concept covering all the technical features of the part to be rolled. By the same token, "machine" stands for all aspects related to the employed threadroller. These aspects are twofold: on the one hand, the technical features of the machine and on the other, the way it is operated.
Below is a list of the most important classes of variables related to the first two factors, i.e. the fastener & the machine, both key determinants to die-life yielded by a set of thread-roll dies. The third factor - the dies - is treated in a separate section which lists die-life figures of IMU dies for user reference.
Each variable listed is considered as independent. All data referred to apply to ISO standard threads within the M1 - M24 range for metric threads and 0-80 - 1" UNC/UNF range for inch threads.

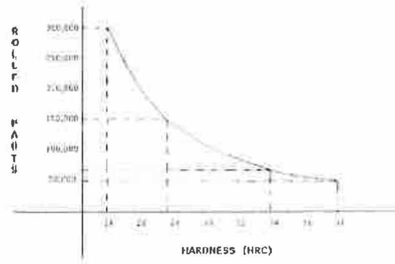
THE FASTENER

Thread Size.
Minor differences in *thread profile* bring major differences in die-life between two virtually identical screws. For example, dies rolling MJ6x1 thread screws will yield significantly more parts, as opposed to those rolling M6x1 screws. The greater radius on the crest of the dies carrying the J thread profile will endure wear significantly better than the same thread size with a standard profile.
Thread diameter & *length* are other important variables.
When two screws differ only in thread diameter, the one with a larger thread diameter will cause greater wear than the one with a smaller diameter. For example, dies rolling M14x1.5 parts will wear out faster than dies rolling M10x1.5 parts, as material displacement during the rolling operation is distributed within a lower number of revolutions. Should these two parts be rolled on a Waterbury 40 roller, the M14 blanks will revolve only 6.53 times vs. 8.16 revolutions for the M10s.
An analysis of the relationship between thread length and die-life is more complex. As a general rule, greater thread length reduces die-life, since greater thread length requires greater rolling pressure. There are exceptions: parts having extremely short thread length (as do some miniature screws) are prone to tilting during the thread-roll operation. The resulting uneven distribution of pressure on the threaded portion of the dies may cause premature chipping.

Part Size & Form.
When the *thread starts directly underhead or on a shank chamfer,* dies are liable to chip on their chamfered corner, thus greatly reducing die-life. A similar problem can occur with parts having *points insufficiently chamfered.* In this case, premature wear will be generated in that area of the die which rolls thread in proximity to the point of the part. *Geometrical inconsistencies of the blank* to be rolled cause a reduction in die-life.
Typical examples are cold headed blanks with an oval shape or inconsistent diameter. These conditions keep the operator from performing proper set-up. The resulting rolling pressure will prove inadequate to optimize die-life. The same problem occurs when blanks have an error in straightness originating either with the cold-heading operations or during heat treatment (for parts rolled after heat treatment).
This analysis of factors which influence die-life does not include a wide range of *non-standard fasteners,* whose geometry may influence die-life negatively. IMU die-life data provided in a separate section will always refer to standard hex or socket head screws with no underhead non-threaded shank.

Heat treatment.
Often un-noticed *variations or inconsistencies in the heat treatment process* of the blank part may affect die wear considerably.
For example, if too short a tempering cycle is performed, the parts will be less ductile when thread-rolled than a part which is properly tempered. Consequently, actual die-life can be considerably reduced.
Alternatively, when heat treatment is not performed under full control, the surface of the parts to roll may be oxidized. This increases friction during the rolling process between the surfaces of the rolled part and the dies, again reducing die-life.

Tensile Strength and Hardness.
When rolling any parts exceeding 110,000 psi or 20 HRC, *minor variations in tensile strength or hardness* greatly affect die-life.
This graph shows the reduction in die-life observed on Standard IMU dies on a Waterbury 10 roller rolling identical M6x1 parts heat treated to different hardness values.



Required grade of quality.

Of all variables, this is the single most significant.

Two fastener makers rolling the same parts to the same specifications will often decide to replace their worn thread-roll dies according to significantly different levels of quality approval. One manufacturer may decide to replace a pair of thread-roll dies after having rolled 30,000 parts, while a competitor rolling the same parts under very similar conditions may decide that 45,000 parts is the right figure. In both cases, threads may be well within geometrical specifications, but inconsistencies or even laps observed on the threads will betray the difference between the two parts. A careful inspection of worn dies normally indicates if all parts rolled with a set of dies conform to the same standard of quality.

THE MACHINE

Machine conditions & operator set-up.

Good machine condition must be presumed; regular maintenance of the threadroller is the key. Two areas of the threadroller deserving special attention are the ramslide and the feeding devices (pusher blades, etc.).

Operator set-up is just as important a pre-condition as a good machine. In the set-up section we suggest a number of steps to optimize the die-life of IMU dies and consequent fastener quality.

In addition to poor machine condition & improper set-up, frequent change-overs can adversely affect die-life. A set of dies which is repeatedly removed from a machine, undergoing different set-ups at different times, will typically yield less parts than a set used on one job till the end of its life.

Speed (pcs/min).

Speed is a variable whose influence on die-life is often underestimated. Experience shows that die-life of IMU dies proportionally increases with speed up to a point, beyond which die-life decreases precipitously. We are not in the position of suggesting the right speed for each application; rather, each customer should optimize speed according to the application. A few useful indications can be found in our die-life charts, referred to below.

Coolant.

Oil is always recommended as a coolant. Again, experience shows that for any application oil maximizes die-life over any type of water-soluble coolant (keeping in mind that running parts with water-soluble coolant - or even dry - usually stems from environmental reasons).

DIE-LIFE OF IMU DIES

The die-life data below requires a few preliminary explanations.

All submitted data are valid provided that all the variables which adversely affect die-life (as previously discussed) are addressed.

IMU dies, whether Standard or Superdie versions, are generally *not* considered to be a variable as they are manufactured according to a very high standard of consistency.

The tensile strength of stainless steel parts always refers to the cold-headed blank (following a certain degree of upset during the cold-heading operation) and *not* to the wire prior to being cold-headed.

Oil is employed as coolant.

Single or split face dies with "boltmaker lead" are preferable over duplex dies in terms of the quality of the rolled part, as their longer and smoother roll-on guarantees a *progressive formation of the thread* which, in the case of duplex dies, occurs in a far lower number of revolutions of the blank. Moreover, single face dies - unlike duplex dies - remain stable in their die-pockets thanks to their flat-ground bottom face. We have included data on both types of dies below.

Die-life is always given per die-edge. Die-life data are recorded for one initial set-up which is not modified - save for an eventual (slight) reduction in die squeeze due to machine heat-up.

Full control of all variables is impossible. Submitted data represent *average values* obtained by comparing tests run by different companies under very similar conditions. These results have been achieved by replacing the dies just before the wear curve manifests itself.

We have divided IMU die-life data into 3 groups depending on rolled material:

parts in stainless steel 300 series

material (AISI)	tensile strength (psi)	machine size*	IMU die version	single face or duplex	thread	thread length (mms)	speed (pcs/min)	***DIE-LIFE*** *(pcs/edge)*
302	85,000	W00/TR0	standard	duplex	2 - 56	6	500	*400,000*
302	85,000	W00/TR0	Superdie	duplex	2 - 56	6	500	*600,000*
304	120,000	W00/TR0	standard	duplex	2 - 56	6	400	*300,000*
304	120,000	W00/TR0	Superdie	duplex	2 - 56	6	400	*450,000*
302	80,000	W0/TR1/GW52	standard	duplex	M3 x 0.5	12	600	*500,000*
302	80,000	W0/TR1/GW52	standard	duplex	4 - 40	12	600	*500,000*
302	80,000	W0/TR1/GW52	standard	duplex	10 - 32	12	600	*500,000*
302	100,000	W0/TR1/GW52	standard	duplex	M3 x 0.5	12	300	*300,000*
302	100,000	W0/TR1/GW52	standard	duplex	4 - 40	12	300	*300,000*
302	100,000	W0/TR1/GW52	standard	duplex	10 - 32	12	300	*270,000*
304	120,000	W0/TR1/GW52	standard	duplex	M3 x 0.5	12	250	*220,000*
304	120,000	W0/TR1/GW52	standard	duplex	4 - 40	12	250	*220,000*
304	120,000	W0/TR1/GW52	standard	duplex	10 - 32	12	250	*200,000*
302	100,000	W10/TR2/GW62	standard	duplex	M6x 1	25	250	*350,000*
302	100,000	W10/TR2/GW62	standard	duplex	1/4 - 20	25	250	*300,000*

parts for automotive applications rolled after heat treatment

material (SAE)	hardness (HRC)	machine size*	IMU die version	single or double face	thread	thread length (mms)	speed (pcs/min)	*DIE-LIFE (pcs/edge)*
5135	24	W10/TR2/GW62	standard	single face	M6x1	20	280	*300,000*
5140	32	W10/TR2/GW62	standard	double face	M8x1.25	20	120	*40,000*
5135	29	W20/TR4	standard	single face	5/16 - 18	45	120	*80,000*
5140	32	W20/TR4	standard	single face	M8x1.25	50	100	*70,000*
5140	32	W20/TR4	standard	single face	M10x1.25	50	100	*60,000*
5140	32	W20/TR4	standard	double face	M10x1.5	25	100	*40,000*
5140	38	W20/TR4	standard	single face	M12x1.25	50	100	*20,000*
5140	32	W30/TR5	standard	single face	M10x1.25	45	130	*75,000*
5140	32	W30/TR5	standard	single face	M10x1.5	45	130	*70,000*
5140	32	W30/TR5	standard	.single face	M12x1.75	45	130	*65,000*
5140	32	W40/TR6	standard	single face	M12x1.5	100	50	*60,000*
5140	38	W50	Superdie	single face	M 16x2	38	90	*25,000*

parts for aircraft applications

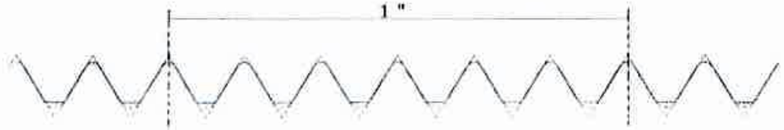
material	hardness (HRC)	machine size*	IMU die version	single or double face	thread	thread length	speed (pcs / min)	*DIE-LIFE (pcs/edge)*
A-286	39	W10/TR2/GW62	Superdie	double face	10-32 UNJ	0.50"	90	*25,000*
8740	36	W10/TR2/GW62	Superdie	double face	10-32 UNJ	0.40"	100	*60,000*
8740	36	W10/TR2/GW62	Superdie	3-die system	10-32 UNJ	0.40"	100	*70,000*
hot rolled Titanium	36	W10/TR2/GW62	Superdie	double face	10-32 UNJ	0.50"	100	*25,000*
Inconel 718	43	W10/TR2/GW62	Superdie	single face	10-32 UNJ	0.50"	60	*10,000*
Inconel 718	43	W20/TR4	Superdie	single face	1/4-28 UNJ	0.80"	60	*12,000*

* machine size: W = Waterbury / TR = Hilgeland / GW = EW Menn

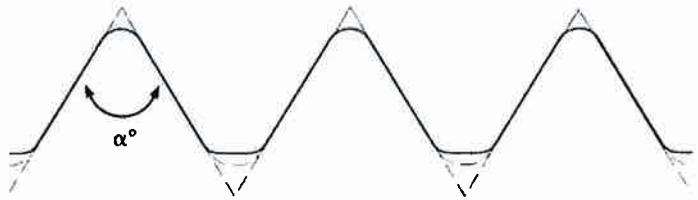
TOLERANCES

The following thread tolerances are *standard* on all IMU dies. If requested, IMU can manufacture dies having tighter tolerances. Special thread profiles are included in the manufacturing program of IMU.

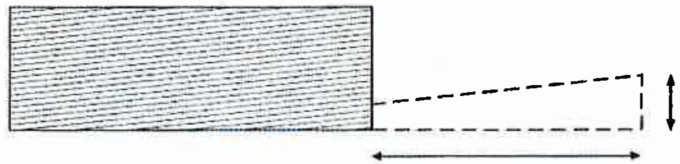
Pitch: + / - 0.01 mms for 25 mms of threaded section



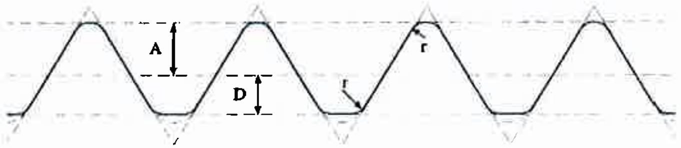
Thread profile angle: + / - 15'



Lead angle: + / - 0.015 mms on 100 mms



Addendum, Dedendum, top & bottom Radii: + / - 0.005 mms



DIE SET-UP PROCEDURE

PRELIMINARY INSTRUCTIONS

Check the following.

1) The ramslide must not have too much play. Place a lever between the ramslide and its pocket and exert pressure by hand. Check play with the aid of a comparator. The maximum play should not exceed 0.10 mms. Make sure to repeat this operation on both ends of the ramslide, testing it at various stages through the stroke.

2) Both die pockets must be clean and devoid of flash or metal chips.

3) Shims (if required) must not have flash and must be perfectly plain.

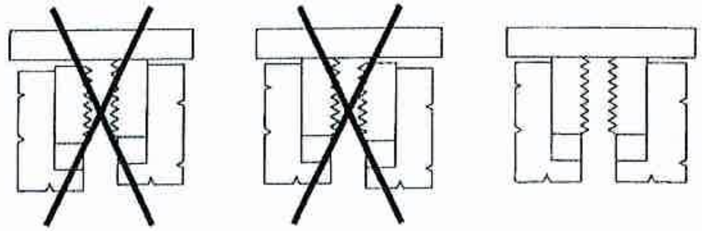
4) When IMU dies are set into the threadroller, the markings on both dies must be visible, i.e. facing up. In the case of duplex dies, the markings of both dies will face up or down at the same time.

5) When using re-ground dies, the total width of each die with shims must equal the initial width of the die when new.

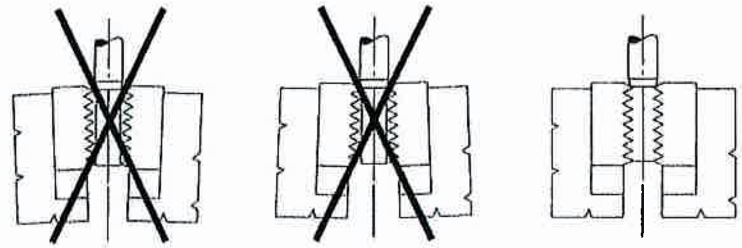
6) After setting the dies into the threadroller, it is always better to reduce die squeeze when rolling the very first parts; otherwise, the dies can be damaged.

7) During the rolling operation, die squeeze has to be kept as low as possible, since a slight excess of pressure will reduce die-life.

STEP 1
Check die upper level, as shown here. Place a perfectly straight steel rule on the upper side of both dies. Let the ramslide move idle and make sure that the upper sides of both dies find themselves at the same level during the 3 following moments: 1) at the start of the stroke, when the blank is fed between the dies; 2) halfway through the stroke, when the centres of both dies face each other; 3) at the end of the stroke, when the part is rolled out of the dies.

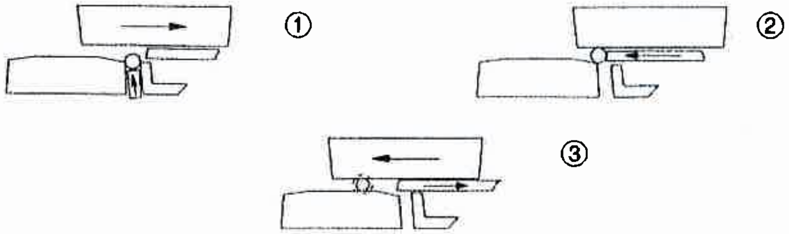


STEP 2
Check die vertical parallelism, as shown here. Roll a blank after having reduced die squeeze, without forming the thread fully; make sure that the external diameter is constant along the whole threaded length: the rolled part must not be conical.

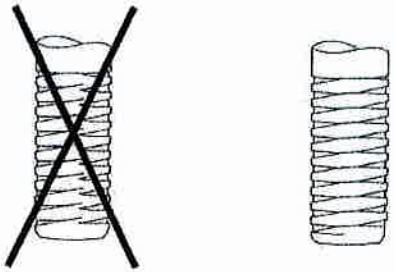


STEP 3
Check die horizontal parallelism and the correct starting position of the blank. Horizontal parallelism is checked by placing gauges in between the straight parts of both dies, i.e. not taking into consideration die tapers. Distances A and B must be equal. In order to achieve a correct start of the blank, C must be equal to the difference in length of both dies, divided by 2.

STEP 4
Check if the blank is fed correctly. Make sure the rails and the pusher blade are not worn out or warped. The set-up has to be carried out so that the blank is properly placed before the dies by the pusher blade, otherwise, if there is play, it may not start off properly.



STEP 5
Check die set-up, as shown here. After having reduced die squeeze as much as possible, the blank must undergo a little more than half a revolution so that the thread crests of the dies mark the shank. Take the blank out from the dies by retreating the moving die and see if the marks left by the moving die match with those left by the fixed die. In case the matching is wrong, correct it by adjusting the fixed die.



STEP 6
Check presence of laps in the screw thread. Laps, as shown here, are formed when the dies are not properly matched. They can be detected in 2 ways. 1) Hydrochloric acid etching: after having taken all the grease off from the rolled parts, place them in the acid and keep them in for about 5-10 minutes, take them out and dry them using warm air. Then check with the aid of a magnifying glass if laps are to be seen on the thread flanks crosswise to the parts' axis. 2) Metallographic microscope: cut the rolled part lengthwise, form a test sample, polish it and check with the microscope if laps appear.

IMU RE-GRINDING SERVICE

In every country where IMU has a permanent die stock, it arranges a pick up service for dies to be re-ground.

Which dies should NOT be re-ground ?

Although IMU re-grinds virtually any used dies, there are cases when re-grinding is *not* recommended.

D2 steel (or equivalent) dies are *not* worth re-grinding by IMU, as the re-grinding price we quote would not be much lower than the average market price of the same dies when new. Moreover, die-users have often noted that a re-ground set of D2 dies frequently has a lower die-life than a new set. Lastly, no coating applied so far by IMU has significantly improved die-life for D2 steel dies.

Dies which should also *not* be re-ground are duplex dies whose corners are chipped beyond two thread depths measured from the thread bottom line (see figure below). This issue is not relevant to the first cut of single face, single entrance dies, as IMU automatically reverses the top side by re-marking the intact bottom side.

Other dies which should *not* be re-ground are those where stress cracks in the thread are deeper than two thread depths measured from the thread bottom line (see figure below). In many cases, this can be detected only when the worn out thread is ground off at the IMU plant. At this stage, IMU determines whether a further reduction in die-thickness can eliminate the cracks or not.

It is important to remark that IMU can easily deal with deep cracks in threads or chipped corners by reducing die thickness or die face, respectively, through supplementary grinding operations.
In consequence, re-grinding cost is increased. We always communicate to the customer any supplementary cost for additional processing and proceed upon customer authorization.

Which dies should be re-ground ?

We definitely recommend re-grinding high speed steel dies in Waterbury 20 (or TR4) size & larger. Re-grinding smaller dies (up to & including Waterbury 10 or TR2 size) may not be cost-effective, as the price for processing may not be much less than 20% below the cost of a new set. There are naturally exceptions to this rule of thumb: depending on the quantity of dies involved and their general condition, competitive re-grinding prices may be quoted for some dies in the Waterbury 10 (or TR2) size or smaller.

There are 2 main reasons which justify re-grinding high speed steel dies.

1) The price of a set of dies (Waterbury 20 or TR4 size & greater) re-ground by IMU is often near to 50% or less than the price of the same set of new IMU dies. This accompanies the fact that the die-life of IMU dies re-ground by IMU is guaranteed to be equal to the die-life of the same dies when new.
2) A coating is ALWAYS applied on any high speed steel dies re-ground by IMU. The IMU coating enhances the wear resistance of the die. Customers often notice how high speed steel dies not manufactured by IMU yield more parts *after* the IMU re-grinding operation.

IMU re-grinding procedure.

Upon arrival at the IMU headquarters, every lot of dies is isolated by customer. Each lot undergoes the following steps:

1) Correspondence is checked between the actual die sizes and those stated on the purchase order of the customer.
Changes in thread size requested by the customer are also noted. Any discrepancy is promptly referred to the customer whose feedback determines how to proceed.
2) Every single set of dies is subjected to visual inspection, in order to determine its effective "re-grindability". Cracks and chipped corners are evaluated, as well as die material. IMU communicates to the customer any information which may require a change in the purchase order and awaits customer approval before proceeding.
3) The worn-out thread is ground-off on all dies, until a perfectly flat surface is obtained. This operation is crucial to the elimination of stress cracks and tensions. The surface is then checked to determine the presence of any residual cracks. A further grinding operation may be necessary in order to eliminate any superficial cracks not exceeding the size of another thread depth. In case cracks still appear after this second surface grinding operation, the dies are set aside and returned to the customer.
4) All the remaining operations are carried out as they would normally be performed during the manufacturing procedure of new dies.

Shimming the dies.
As re-grinding automatically reduces die thickness, the customer usually provides the shims necessary to compensate for the reduction in thickness once the re-ground dies are re-installed into the die-pockets of the threadroller.
However, the following two alternatives are available:
1) IMU can establish a fixed multiple of reduction in die-thickness (2 mms, for example) for each re-grinding operation. This enables the customer to keep pre-measured shims in multiples of 2 mms without having to guess the thickness of the required shim once the re-ground dies have to be used.
2) IMU supplies the shims together with the re-ground dies. Usually, one set of shims is supplied for every ten sets of identical dies.
An extra cost applies for both of these alternatives.

Why re-grinding is cost-effective.

IMU maintains a minimum thickness value of 12 mms for any re-ground die. Thus, a thread-roll die can potentially undergo quite a number of re-grinding operations before being scrapped. However, it is quite safe to say that a set of thread-roll dies would usually allow at least two re-grinding operations.
Keeping this figure in mind, we will quantify the cost reduction achieved by re-grinding one set twice versus purchasing two new sets of dies.

We have stated above that some brands of high speed steel dies may yield more parts when re-ground by IMU than when they were new. According to the hypothesis illustrated below, we will assume that the re-ground dies will yield the same amount of parts as new dies.

Data:

Price of 1 new set of dies	200 Euros
Price of 1 re-grinding operation	100 Euros
Parts rolled with 1 set of dies (new or re-ground)	50,000
Total amount of parts to be rolled	150,000

1° solution: NO re-grinding, only new dies are purchased

Total cost of dies: 200 Euros x 3	600 Euros
Die cost for each rolled part (600 Euros/ 150,000)	0.0040 Euros

2° solution: 2 re-grinding operations are carried out on 1 purchased set of new dies

Total cost of dies: (200 Euros x 1) + (100 Euros x 2)	400 Euros
Die cost for each rolled part (400 Euros/ 150,000)	0.0026 Euros (minus 35% of die cost)

FLAT DIE TEST REPORT

Please make copies of this form and fill them in when using IMU dies.
You may fax to us the filled copies or send them as e-mail attachments.

DATE				
CUSTOMER				
DIES				
Machine Size				
Die face				
Duplex / Single face / Split face				
Thread				
Die version				
ROLLED PARTS				
Rolled length				
Overall length				
Rolled material (specify if hardened)				
Hardness (HRC) or Tensile Strength (psi)				
OPERATING CONDITIONS				
Machine speed				
Coolant				
DIE-LIFE				
	EDGE 1	EDGE 2	EDGE 3	EDGE 4
Pair # 1				
Pair # 2				
Pair # 3				
Pair # 4				
DIE-LIFE FROM COMPETITORS				
REMARKS				

I.M.U. sas	MIN – MAX DIMENSIONS (MM) Metric threads, COARSE (TOLERANCE CLASS 6g)			Table 1.2.4 - Rev. 0 Date: 12-12-1998
Nominal thread	**Pitch**	**Outer Diameter**	**Pitch Diameter**	**Blank Diameter**
M 1	0,25	0,960 - 1,000 (6h)	----	----
M 1,2	0,25	1,165 - 1,200 (6h)	0,960 - 1,025	0,960 - 0,980
M 1,4	0,30	1,360 - 1,400 (6h)	1,120 - 1,188	1,140 - 1,160
M 1,6	0,35	1,496 - 1,581	1,291 - 1,354	1,310 - 1,330
M 2	0,40	1,886 - 1,981	1,654 - 1,721	1,680 - 1,700
M 2,2	0,45	2,080 - 2,180	1,817 - 1,888	1,840 - 1,860
M 2,5	0,45	2,380 - 2,480	2,117 - 2,188	2,140 - 2,165
M 3	0,50	2,874 - 2,980	2,580 - 2,655	2,610 - 2,635
M 4	0,70	3,833 - 3,978	3,433 - 3,523	3,470 - 3,500
M 5	0,80	4,826 - 4,976	4,361 - 4,456	4,400 - 4,430
M 6	1	5,794 - 5,974	5,212 - 5,324	5,250 - 5,290
M 8	1,25	7,760 - 7,974	7,042 - 7,160	7,070 - 7,120
M 10	1,50	9,732 - 9,968	8,862 - 8,994	8,900 - 8,950
M 12	1,75	11,701 - 11,966	10,679 - 10,829	10,740 - 10,790
M 14	2	13,682 - 13,962	12,503 - 12,663	12,570 - 12,630
M 16	2	15,682 - 15,962	14,508 - 14,663	14,570 - 14,630
M 18	2,50	17,623 - 17,958	16,164 - 16,334	16,250 - 16,300
M 20	2,50	19,623 - 19,958	18,164 - 18,334	18,230 - 18,300
M 22	2,50	21,623 - 21,958	20,164 - 20,334	20,230 - 20,300
M 24	3	23,577 - 23,958	21,803 - 22,003	21,870 - 21,920

I.M.U. sas	MIN – MAX DIMENSIONS (MM) Metric threads, FINE (TOLERANCE CLASS 6g)			Table 1.2.4 - Rev. 0 Date: 12-12-1998
Nominal thread	**Pitch**	**Outer Diameter**	**Pitch Diameter**	**Blank Diameter**
M 8 x 1	1	7,794 - 7,974	7,212 - 7,324	7,250 - 7,290
M 10 x 1,25	1,25	9,760 - 9,974	9,042 - 9,160	9,070 - 9,120
M 12 x 1,25	1,25	11,760 - 11,972	11,028 - 11,160	11,070 - 11,120
M 14 x 1,5	1,50	13,732 - 13,968	12,854 - 12,994	12,900 - 12,950
M 16 x 1,5	1,50	15,732 - 15,968	14,854 - 14,996	14,900 - 14,950
M 18 x 1,5	1,50	17,732 - 17,968	16,854 - 16,994	16,900 - 16,950
M 20 x 1,5	1,50	19,732- 19,968	18,854 - 18,994	18,900 - 18,950
M 22 x 1,5	1,50	21,732 - 21,968	20,854 - 20,994	20,900 - 20,950
M 24 x 2	2	23,682 - 23,962	22,493 - 22,663	22,570 - 22,630

I.M.U. sas	MIN – MAX DIMENSIONS (MM) **Inch threads, COARSE** **(UNC)** (TOLERANCE CLASS 6g)	Table 1.2.4 - Rev. 0 Date: 12-12-1998

Nominal thread	TPI	Outer Diameter	Pitch Diameter	Blank Diameter
# 1	64	1,854 *(nominal)*	1,598 *(nominal)*	---
# 2	56	2,184 *(nominal)*	1,890 *(nominal)*	---
# 3	48	2,515 *(nominal)*	2,172 *(nominal)*	---
# 4	40	2,695 - 2,824	2,350 - 2,410	2,360 - 2,380
# 5	40	3,025 - 3,155	2,677 - 2,743	2,690 - 2,720
# 6	32	3,333 - 3,485	2,898 - 2,969	2,910 - 2,940
# 8	32	3,990 - 4,143	3,553 - 3,627	3,590 - 3,620
# 10	24	4,613 - 4,801	4,028 - 4,112	4,070 - 4,100
# 12	24	5,278 - 5,461	4,686 - 4,773	4,700 - 4,740
1/4"	20	6,116 - 6,322	5,403 - 5,497	5,430 - 5,470
5/16"	18	7,686 - 7,907	6,888 - 6,990	6,920 - 6,960
3/8"	16	9,253 - 9,492	8,349 - 8,461	8,400 - 8,440
7/16"	14	10,815 - 11,077	9,779 - 9,898	9,820 - 9,860
1/2"	13	12,385 - 12,662	11,265 - 11,392	11,310 - 11,350
5/8"	11	15,527 - 15,834	14,196 - 14,336	14,250 - 14,290
3/4"	10	18,677 - 19,004	17,203 - 17,353	17,260 - 17,300
7/8"	9	21,824 - 22,177	20,183 - 20,343	20,230 - 20,280
1"	8	24,968 - 25,349	23,114 - 23,280	23,160 - 23,210

I.M.U. sas	MIN – MAX DIMENSIONS (MM) **Inch threads, FINE** **(UNF)** (TOLERANCE CLASS 6g)	Table 1.2.4 - Rev. 0 Date: 12-12-1998

Nominal thread	TPI	Outer Diameter	Pitch Diameter	Blank Diameter
# 0	80	1,524 *(nominal)*	1,318 *(nominal)*	---
# 1	72	1,854 *(nominal)*	1,626 *(nominal)*	---
# 2	64	2,184 *(nominal)*	1,928 *(nominal)*	---
# 3	56	2,515 *(nominal)*	2,220 *(nominal)*	---
# 4	48	2,845 *(nominal)*	2,502 *(nominal)*	---
# 5	44	3,175 *(nominal)*	2,799 *(nominal)*	---
# 6	40	3,355 - 3,483	3,007 – 3,073	3,020 - 3,050
# 8	36	4,006 - 4,145	3,617 - 3,688	3,630 - 3,660
# 10	32	4,651 - 4,803	4,211 - 4,288	4,280 - 4,300
# 12	28	5,296 - 5,461	4,790 - 4,872	4,820 - 4,850
1/4"	28	6,160 - 6,325	5,652 - 5,735	5,670 - 5710
5/16"	24	7,727 - 7,910	7,127 - 7,221	7,160 - 7,200
3/8"	24	9,314 - 9,497	8,712 - 8,809	8,740 - 8,780
7/16"	20	10,874 - 11,079	10,147 - 10,254	10,180 - 10,220
1/2"	20	12,461 - 12,667	11,722 - 11,840	11,760 - 11,800
5/8"	18	15,618 - 15,839	14,803 - 14,922	14,840 - 14,880
3/4"	16	18,773 - 19,012	17,854 - 17,981	17,900 - 17,940
7/8"	14	21,923 - 22,184	21,869 - 22,006	21,910 - 21,950
1"	12	25,065 - 25,354	23,830 - 23,980	23,900 - 23,950

THREAD-ROLLING DIES

IMU DIES SA
Strada Regina 42, CH-6934 Bioggio
Switzerland
Tel: +41-91-6051720/1
Fax: +41-91-6051722