boehlerit

Adam ROLLSYSTEME

Thread rolling systems

Rolling attachments, re-defined

Boehlerit is extending its product portfolio and has found a competent partner for advice on and application of profile and thread rolling heads as well as the design of customer-specific, purpose-built models of axial and tangential rolling systems in Adam Rollsysteme GmbH.

In the aerospace industry, for instance, machining is considered an undesirable processing method due to the associated destruction of the milling fibres. With rolling, the desired profile is pressed into the material beyond the stress-strain limit.

The Adam axial and tangential rolling systems by Boehlerit offer not just the shortest cycle times, long tool life, perfect surface qualities and outstanding precision, but are also highly economical as they reduce the amount of material used. The Adam axial rolling systems cover a working range of 1.4 to 100 mm and are primarily used on turning and milling centres to process threads and profiles.
The tangential rolling systems, on the other hand, are ideal for manufacturing extremely short threads, threads with very short runouts, knurls and smaller gears. The working range lies at 1.6 to 42 mm, with a roll width of 15.5 to 31 mm.

With every Adam tangential rolling system, Boehlerit supplies customised rolling head holders for fitting the rolling head to the tooling machine. With these rolling systems, the Kapfenberg-based company offers a wide range of tool solutions that will suit most application scenarios.

BOEHLERIT Kapfenberg in Styria/Austria

Adam axial rolling systems

The broad working range of the individual rolling head types is made possible by the simple and fast exchange process for the rolls. As a next step, other cold forming processes such as smoothing, milling and beading can also be performed. The axial rolling heads may be used in stationary or rotating applications. The axial rolling head is locked by radial turning of the locking handle or by means of an optional, automated locking mechanism. The rolling head opens by stopping the infeed and the rolls release the workpiece. Depending on the design, the axial rolling head is equipped with 2, 3 or in some cases even 6 thread rolls, which are used on a set-by-set basis.
The axial rolling systems may be used for short and long threads.

High-precision thread rolls:

The thread rolls are adapted to the profile to be manufactured in terms of diameter, shape and flank lead and constitute the forming tool. Different shaft variations are available for different machines.

Right-hand as well as left-hand threads may be produced just as easily as regular threads, fine threads, pipe threads, trapezoidal threads and special threads.

Benefits:

- Broad working ranges
- Rotating and stationary for use on machining centres, turning lathes, automatic rotary indexing machines and special-purpose machines
- Machining of parts with long threads
- Self-opening by means of infeed stop for touch-free return travel
- Reproducible manufacturing results

A wide roller programme is available. The dimensional accuracy of the rolled threads is guaranteed for materials of up to a maximum tensile strength of 1400 N/mm².
Stationary thread rolling head:

The Adam thread rolling head in a stationary design was developed for use with rotating workpieces.
The opening of the thread end may be performed by means of an infeed stop of the machine or by limiting the infeed with an internal stop.

The closing process may be performed either manually or with suitable locking devices for automated locking.

Rotating thread rolling head:

The Adam thread rolling head in a rotating design was developed for use with stationary workpieces. The rotating axial rolling heads follow the same principle as the stationary models. Just like the stationary model, the rotating axial rolling head remains locked and continues to machine your thread until either the machine infeed is stopped or the workpiece reaches the pre-set internal stop. This process also pulls the rotary axial rolling head out of its coupling stage, thereby opening it. The thread rolls will turn away from the surface of the workpiece over their eccentric cams. The backwards movement of the rolling head to detach it from the workpiece is controlled by the tooling machine.
To prepare the axial rolling head for the next rolling process, the rotating version must also be locked. Again, this may be done effectively and comfortably using automatic locking devices. Their function is controlled by the tooling machine and activated by pressurised air or cooling agent.

Adam axial rolling systems may be used on all standard tooling machines, for instance on CNC machining centres, manual tooling machines and in straightforward applications such as stationary drilling machines and boring mills. Set-up on your tooling machine is quick, easy and flexible for all applications.

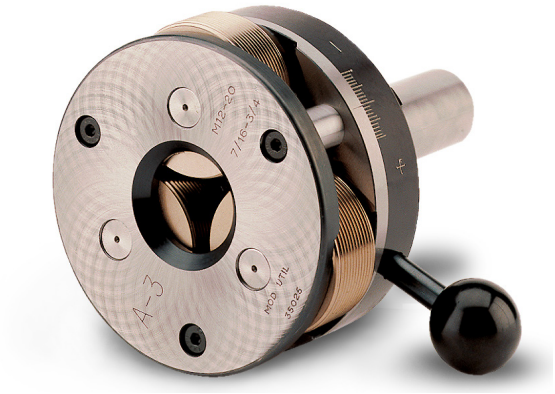
The quality of the manufactured threads as well as the tool life of Adam rolling systems and their thread and profile rolls are the most important arguments in our favour when compared to cutting tools. These advantages result in extremely short set-up and downtimes as well as in fast cycle times during the production process of your threads and profiles. Adam rolling systems also come with the option of cost-effective locking mechanisms, which further reduce cycle times and make for an even faster and more comfortable set-up.

Shank design

Typ A: Stationary use (e. g. „A 12“)
Typ AG: Stationary and rotating use (e. g. „A 12 G“), for left-hand threads: additional „L“ (e. g. „A 12 L“)

Flange design

Stationary and rotating use



Shank design

Flange design

Overview of axial rolling systems – types and sizes

Rolling head system - size	Working range		D - shaft		D - housing	
			Diameter - Standard		Diameter - Standard	
	from mm	to mm	mm	Zoll	mm	Zoll
A 0	2,6	5,5	20	3/4“	50	1,9680
A 001	2,6	4,0	20, 16	3/4“	40	1,5748
A 01	3,5	6,0	20, 16	3/4“	40	1,5748
A 1	6,0	11,0	20, 16	3/4“	64	2,5196
A 12	6,0	12,0	20, 16	3/4“	64	2,5196
A 1223	5,0	8,0	20, 16	3/4“	56	2,2047
A 2	8,0	16,0	25	1“	88	3,4645
A 23	8,0	22,0	25	1“	88	3,4645
A 233400	16,0	36,0	30, 25	1“, 1.1/4“	96	3,7795
A 3	12,0	22,0	30	1.1/2“, 1.1/4“	117	4,6063
A 34	12,0	30,0	30	1.1/2“, 1.1/4“	117	4,6063
Rolling head system - size	**Working range**		**D - Flange**		**D - Flange**	
			Durchmesser - Standard		**Durchmesser - Standard**	
	from mm	**to mm**	**mm**	**Zoll**	**mm**	**Zoll**
A 4-1	14	30	140	5,5118	165	6,4960
A 45-1	16	42	140	5,5118	165	6,4960
A 5-1	18	39	200	7,8740	200	7,8740
A 56-1	22	52	200	7,8740	200	7,8740
A 6b-1	30	45	200	7,8740	255	10,0393

Shank design

Flange design

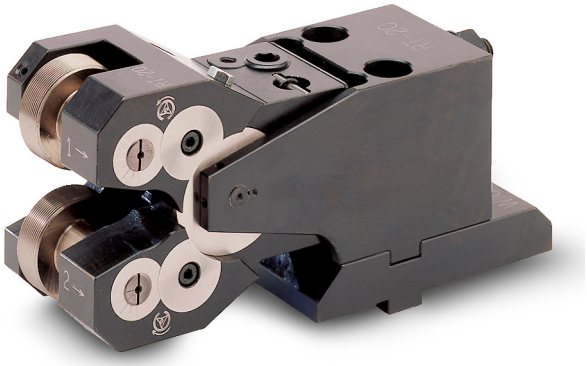
Adam tangential rolling systems

Adam tangential rolling systems will increase your efficiency in thread and profile production on CNC machining centres, CNC turning machines and on all manual cross-slide machines.

The main advantage of our tangential thread rolling systems is the option to roll threads as well as profiles within a workpiece, between shoulders and varying diameters and whilst rolling shortest threads and run-ons.
Combine these advantages with ultrashort cycle times, and the capacity of your machine tools will be increased dramatically.

Our tangential rolling systems move laterally across the workpiece and are fitted with two thread rolls. These are used on a set-by-set basis. A release mechanism is not required. The length of the thread results from the width of the rolling head.

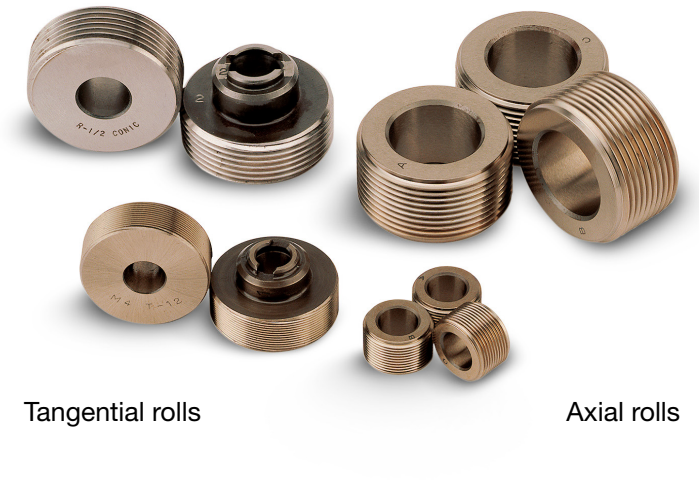
Adam rolling systems tangential system
TR 20, e.g. with 2-part holder for fitting on a cross-slide machine



Overview of Adam tangential rolling systems – types and sizes

Rolling head system - size	Working range		Width of roll, max.		Length of rolling head, min.	
	from mm	to mm	mm	Zoll	mm	Zoll
TR10	2	14	15,5	0,6102	104	4,09 44
TR20	2	30	21,5	0,8464	131	5,1574
TR30	2	42	31,0	1,2204	168	6,614

Every Adam tangential rolling system comes with an individually adjustable tangential rolling head holder, which is used for fitting and fixing the thread rolling head to your tooling machine.



Tangential rolls

Axial rolls

Designs/versions
Roll sets for thread rolling systems by different manufacturers, for instance LMT-FETTE, WAGNER, WINTER, REED, etc.

Roll sets for all standard thread and profile rolling machines

Thread rolls and dies

We also supply matching thread and pro¬file rolls for our Adam rolling systems. All of our thread and profile rolls are designed and manufactured according to the latest technologies and findings and tailor-made for your individual application.

Adam thread rolls and dies are made on state-of-the-art CNC grinding centres. Our roll production has been ISO 9001-certified since 1993.
For our thread rolls and dies, we use a wide range of high-performance materials from Western European manufacturers, always in line with individual requirements. All heat and surface treatments are performed in state-of-the-art vacuum and protective gas furnaces and to a reproducible quality standard.

Our entire manufacturing process is based on many years‘ experience with using these rolls for rolling systems and rolling machines.
For this reason, Adam rolls have a long tool life that in turn reduces the set-up and downtimes of your tooling machines and make the use of Adam rolling systems particularly efficient.

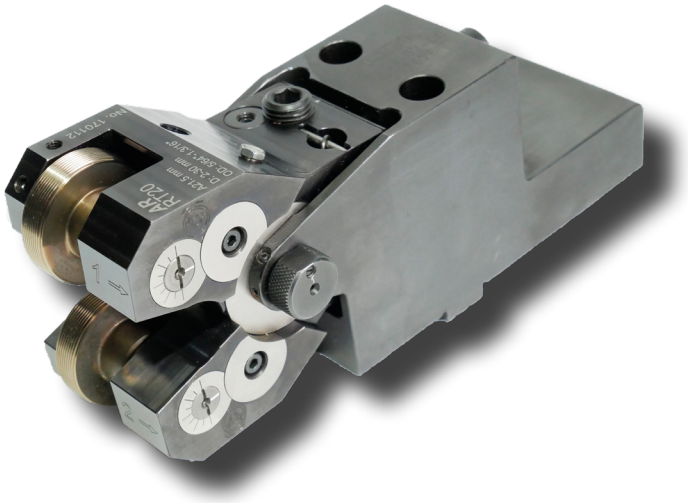
We are also happy to supply you with thread and profile rolls from other manufacturers that perfectly match these roll systems. Adam thread rolls and dies are suitable for infeed our throughfeed applications. We supply the right rolls for threads and profiles in all shapes and sizes that fit all standard die machines, in the same outstanding quality as our rolls for rolling systems.

Each set of Adam dies is customised to suit your specific application and requirements. For Adam dies, we also supply high-precision plunge rolls with radius-runout (RRO) in a variety of formats. Adam thread rolls and dies are used in aerospace and automotive engineering, in racing and of course in tool and machine construction.

Dies

Rolling systems

Adam rolling systems use material sparingly - there is no costly waste in the form of chips. Adam rolling systems allow for the high-precision production of nearly all thread sizes and types as well as for special applications such as flanging, radii, knurling and gearing. The workpiece surfaces obtain a press-polished surface quality. Adam rolling systems may be used universally, thereby increasing productivity. They are used in a wide range of industries, such as the automotive industry, the supply industry and in machine construction. Adam rolling systems may also be used efficiently in smaller batch sizes.



Service/maintenance and repair

Our service includes the analysis of the condition of your rolling system and the compilation of a cost estimate. You will be invoiced only for the required spare parts and the return delivery – labour is included in the free service package.
We are also happy to service most rolling systems from other manufacturers that are still in use at your facility.

Technical data:

Adam thread rolling heads are suitable for the machining of all materials with cold-forming properties.
The required strain of the material depends on the forming size.

Workpiece preparation:

The starting diameter must be prepared with narrow tolerances (for the pre-machining diameter,
please see the tables from page 8 to 11).
A chamfer with an angle of approximately 10 - 30° is required.

Tensile strength:

During cold-forming, the tensile strength of the material will increase. The fibre orientation is not disturbed, resulting in a higher static and dynamic tensile strength.

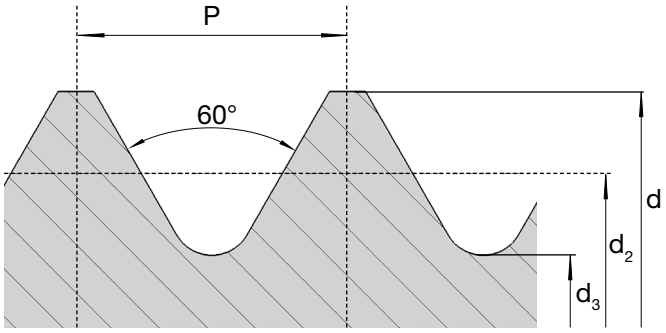
Rolling speed:

The rolling speed ranges from 20m/min to 80m/min (in exceptional cases, up to 100m/min). The thread is produced in a single run (for guiding values on rolling speeds, please see the table on pages 12 and 13.)

Surface quality of the thread flank:

The surface quality of the thread flank is very high as the flank is burnished. This also results in a low corrosion tendency.

Thread limit dimensions and lead angle for bolt threads see DIN 13



d = Bolt major-Ø
d_2 = Bolt pitch-Ø
d_3 = Bolt minor-Ø

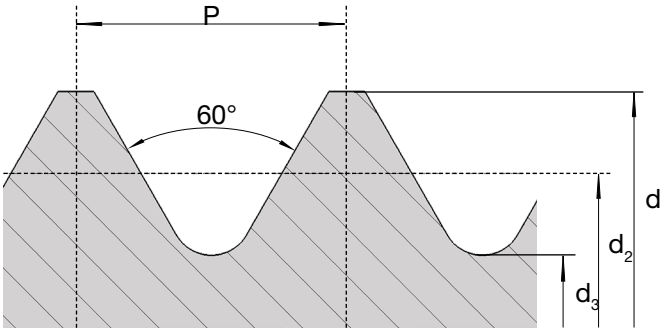
Lead-∢ β to nominal diameter d_2

Thread- Nominal Ø	pitch P	Tolerance field (mm) 4 h d max.	4 h d min.	4 h d_2 max.	4 h d_2 min.	4 h d_3 max.	6 g d max.	6 g d min.	6 g d_2 max.	6 g d_2 min.	6 g d_3 max.	6 e d max.	6 e d min.	6 e d_2 max.	6 e d_2 min.	6 e d_3 max.	Lead ∢ β Deg., min.
M 1,6	x 0,35	1,600	1,547	1,373	1,333	1,170	1,581	1,496	1,354	1,291	1,151	1,554	1,469	1,327	1,264	1,124	4° 38'
M 1,8	x 0,35	1,800	1,747	1,573	1,533	1,370	1,781	1,696	1,554	1,491	1,351	1,754	1,669	1,527	1,464	1,324	4° 3'
M 2	x 0,4	2,000	1,940	1,740	1,698	1,509	1,981	1,886	1,721	1,654	1,490	1,952	1,857	1,692	1,625	1,461	4° 11'
M 2,2	x 0,45	2,200	2,137	1,908	1,863	1,648	2,180	2,080	1,888	1,817	1,628	2,152	2,052	1,860	1,789	1,600	4° 17'
M 2,5	x 0,45	2,500	2,437	2,208	2,163	1,948	2,480	2,380	2,188	2,117	1,928	2,452	2,352	2,160	2,089	1,900	3° 42'
M 3	x 0,5	3,000	2,933	2,675	2,627	2,387	2,980	2,874	2,655	2,580	2,367	2,950	2,844	2,625	2,550	2,337	3° 24'
M 3,5	x 0,6	3,500	3,420	3,110	3,057	2,764	3,479	3,354	3,089	3,004	2,743	3,447	3,322	3,057	2,972	2,711	3° 30'
M 4	x 0,7	4,000	3,910	3,545	3,489	3,141	3,978	3,838	3,523	3,433	3,119	3,944	3,804	3,489	3,399	3,085	3° 36'
M 4,5	x 0,75	4,500	4,410	4,013	3,957	3,580	4,478	4,338	3,991	3,901	3,558	4,444	4,304	3,957	3,867	3,524	3° 24'
M 5	x 0,8	5,000	4,905	4,480	4,420	4,019	4,976	4,826	4,456	4,361	3,995	4,940	4,790	4,420	4,325	3,959	3° 15'
M 6	x 1	6,000	5,888	5,350	5,279	4,773	5,974	5,794	5,324	5,212	4,747	5,940	5,760	5,290	5,178	4,713	3° 24'
M 7	x 1	7,000	6,888	6,350	6,279	5,773	6,974	6,794	6,324	6,212	5,747	6,940	6,760	6,290	6,178	5,713	2° 52'
M 8	x 1,25	8,000	7,868	7,188	7,113	6,466	7,972	7,760	7,160	7,042	6,438	7,937	7,725	7,125	7,007	6,403	3° 10'
M 9	x 1,25	9,000	8,868	8,188	8,113	7,466	8,972	8,760	8,160	8,042	7,438	8,937	8,725	8,125	8,007	7,403	2° 46'
M 10	x 1,5	10,000	9,850	9,026	8,941	8,160	9,968	9,732	8,994	8,862	8,128	9,933	9,697	8,959	8,827	8,093	3° 1'
M 11	x 1,5	11,000	10,850	10,026	9,941	9,160	10,986	10,732	9,994	9,862	9,128	10,933	10,697	9,959	9,827	9,093	2° 43'
M 12	x 1,75	12,000	11,830	10,863	10,768	9,853	11,966	11,701	10,829	10,679	9,819	11,929	11,664	10,792	10,642	9,782	2° 56'
M 14	x 2	14,000	13,820	12,701	12,601	11,546	13,962	13,682	12,663	12,503	11,508	13,929	13,649	12,630	12,470	11,475	2° 52'
M 16	x 2	16,000	15,820	14,701	14,601	13,546	15,962	15,682	14,663	14,503	13,508	15,929	15,649	14,630	14,470	13,475	2° 28'
M 18	x 2,5	18,000	17,788	16,376	16,270	14,933	17,958	17,623	16,334	16,164	14,891	17,920	17,585	16,296	16,126	14,853	2° 46'
M 20	x 2,5	20,000	19,788	18,367	18,270	16,933	19,958	19,623	18,334	18,164	16,891	19,920	19,585	18,269	18,126	16,853	2° 28'
M 22	x 2,5	22,000	21,788	20,376	20,270	18,933	21,958	21,623	20,334	20,164	18,891	21,920	21,585	20,296	20,126	18,853	2° 14'
M 24	x 3	24,000	23,764	22,051	21,926	20,319	23,952	23,577	22,003	21,803	20,271	23,915	23,540	21,996	21,766	20,234	2° 28'
M 27	x 3	27,000	26,764	25,051	24,926	23,319	26,952	26,577	25,003	24,803	23,271	26,915	26,540	24,966	24,766	23,234	2° 10'
M 30	x 3,5	30,000	29,735	27,727	27,595	25,706	29,947	29,522	27,674	27,462	25,653	29,910	29,485	27,637	27,425	25,616	2° 18'
M 33	x 3,5	33,000	32,735	30,727	30,595	28,706	32,947	32,522	30,674	30,462	28,653	32,910	32,485	30,637	30,425	28,616	2° 4'
M 36	x 4	36,000	35,700	33,402	33,262	31,093	35,940	35,465	33,342	33,118	31,033	35,905	35,430	33,307	33,083	30,998	2° 11'
M 39	x 4	39,000	38,700	36,402	36,262	34,093	38,940	38,465	36,342	36,118	34,033	38,905	38,430	36,307	36,083	33,988	2°
M 42	x 4,5	42,000	41,685	39,077	38,927	36,479	41,937	41,437	39,014	38,778	36,416	41,900	41,400	38,977	38,741	36,379	2° 6'
M 45	x 4,5	45,000	44,685	42,077	41,927	39,479	44,397	44,437	42,014	41,778	39,416	44,900	44,400	41,977	41,741	39,379	1° 57'
M 48	x 5	48,000	47,665	44,752	44,592	41,866	47,929	47,399	44,681	44,431	41,795	47,894	47,364	44,646	44,396	41,790	2° 2'
M 52	x 5	52,000	51,665	48,752	48,592	45,866	51,929	51,399	48,681	48,431	45,795	51,894	51,364	48,646	48,396	45,760	1° 52'
M 56	x 5,5	56,000	55,645	52,428	52,258	49,252	55,925	55,365	52,353	52,088	49,177	55,888	55,328	52,316	52,051	49,140	1° 54'
M 60	x 5,5	60,000	59,645	56,428	56,258	53,252	59,925	59,365	56,353	56,088	53,177	59,888	59,328	56,316	56,051	53,140	1° 46'
M 64	x 6	64,000	63,625	60,103	59,923	56,639	63,920	63,320	60,023	59,743	56,559	63,882	63,282	59,985	59,705	56,521	1° 49'
M 68	x 6	68,000	67,625	64,103	63,923	60,639	67,920	67,320	64,023	64,743	60,559	67,882	67,282	63,985	63,705	60,521	1° 42'

Example of a bolt thread designation (tolerance centre): M 16 - 6g
Example of a bolt left-hand thread designation (tolerance centre): M 16 - 6g-LH

Metric ISO common threads

Thread limit dimensions and lead angle for bolt threads see DIN 13



d = Bolt major-Ø
d_2 = Bolt-pitch-Ø
d_3 = Bolzen minor-Ø

Lead-∢ β to nominal diameter d_2

Thread- Nomi-nal- Ø	pitch P	Tolerance field (mm)															Lead β Deg., min.
		4 h					6 g					6 e					
		d		d_2		d_3	d		d_2		d_3	d		d_2		d_3	
		max.	min.	max.	min.	max.	max.	min.	max.	min.	max.	max.	min.	max.	min.	max.	
MF	2,5 x 0,35	2,500	2,447	2,273	2,233	2,070	2,481	2,396	2,254	2,191	2,051	2,454	2,369	2,227	2,164	2,024	2° 48'
MF	3 x 0,35	3,000	2,947	2,773	2,731	2,570	2,981	2,896	2,754	2,687	2,551	2,954	2,869	2,727	2,660	2,524	2° 18'
MF	3,5 x 0,35	3,500	3,447	3,273	3,231	3,070	3,481	3,396	3,254	3,187	3,051	3,454	3,369	3,227	3,160	3,024	1° 57'
MF	4 x 0,5	4,000	3,933	3,675	3,627	3,387	3,980	3,874	3,655	3,580	3,367	3,950	3,844	3,625	3,550	3,337	2° 28'
MF	4,5 x 0,5	4,500	4,433	4,175	4,127	3,887	4,480	4,378	4,155	4,080	3,867	4,450	4,344	4,125	4,050	3,837	2° 10'
MF	5 x 0,5	5,000	4,933	4,675	4,627	4,387	4,980	4,874	4,655	4,580	4,367	4,950	4,844	5,625	4,550	4,337	1° 57'
MF	5,5 x 0,5	5,500	5,433	5,175	5,127	4,887	5,480	5,374	5,155	5,080	4,867	5,450	5,344	5,125	5,050	4,837	1° 45'
MF	6 x 0,5	6,000	5,933	5,675	5,622	5,387	5,980	5,784	5,655	5,570	5,367	5,950	5,844	5,625	5,540	5,337	1° 36'
MF	6 x 0,75	6,000	5,910	5,513	5,450	5,080	5,978	5,838	5,491	5,391	5,058	5,944	5,804	5,457	5,357	5,024	2° 28'
MF	7 x 0,75	7,000	6,910	6,513	6,450	6,080	6,978	6,838	6,491	6,391	6,058	6,944	6,804	6,457	6,357	6,024	2° 6'
MF	8 x 0,75	8,000	7,910	7,513	7,450	7,080	7,978	7,838	7,491	7,391	7,058	7,944	7,804	7,457	7,357	7,024	1° 49'
MF	8 x 1	8,000	7,888	7,350	7,279	6,773	7,974	7,794	7,324	7,212	6,747	7,940	7,760	7,290	7,178	6,713	2° 28'
MF	9 x 0,75	9,000	8,910	8,513	8,450	8,080	8,978	8,838	8,491	8,391	8,058	8,944	8,804	8,457	8,357	8,024	1° 36'
MF	9 x 1	9,000	8,888	8,350	8,279	7,773	8,974	8,794	8,324	8,212	7,747	8,940	8,760	8,290	8,178	7,713	2° 10'
MF	10 x 0,75	10,000	9,910	9,513	9,450	9,080	9,978	9,838	9,491	9,391	9,058	9,944	9,804	9,457	9,357	9,024	1° 26'
MF	10 x 1	10,000	9,888	9,350	9,279	8,773	9,974	9,794	9,324	9,212	8,747	9,940	9,760	9,290	9,178	8,713	1° 57'
MF	10 x 1,25	10,000	9,868	9,188	9,113	8,466	9,972	9,760	9,160	9,042	8,438	9,937	9,725	9,125	9,007	8,403	2° 28'
MF	11 x 0,75	11,000	10,910	10,513	10,450	10,080	10,978	10,838	10,491	10,391	10,058	10,944	10,804	10,457	10,357	10,024	1° 18'
MF	11 x 1	11,000	10,888	10,350	10,279	9,773	10,974	10,794	10,234	10,212	9,747	10,490	10,760	10,290	10,178	9,713	1° 45'
MF	12 x 0,75	12,000	11,910	11,513	11,446	11,080	11,978	11,838	11,491	11,385	11,058	11,944	11,804	11,457	11,351	11,024	1° 11'
MF	12 x 1	12,000	11,888	11,350	11,275	10,773	11,974	11,794	11,324	11,206	10,747	11,940	11,760	11,290	11,172	10,713	1° 36'
MF	12 x 1,25	12,000	11,868	11,188	11,103	10,466	11,972	11,760	11,160	11,028	10,438	11,937	11,725	11,125	10,933	10,403	2° 2'
MF	12 x 1,5	12,000	11,850	11,026	10,936	10,160	11,968	11,732	10,994	10,854	10,128	11,933	11,697	10,959	10,819	10,093	2° 28'
MF	14 x 1	14,000	13,888	13,350	13,275	12,773	13,974	13,794	13,324	13,206	12,747	13,940	13,760	13,290	13,172	12,713	1° 22'
MF	14 x 1,5	14,000	13,850	13,026	12,936	12,160	13,968	13,732	12,994	12,854	12,128	13,933	13,697	12,959	12,819	12,093	2° 6'
MF	16 x 1	16,000	15,888	15,350	15,275	14,773	15,974	15,794	15,324	15,206	14,747	15,940	15,760	15,290	15,172	14,713	1° 11'
MF	16 x 1,5	16,000	15,850	15,026	14,936	14,160	15,968	15,732	14,994	14,854	14,128	15,933	15,697	14,959	14,819	14,093	1° 49'
MF	18 x 1	18,000	17,888	17,350	17,275	16,773	17,974	17,794	17,324	17,206	16,747	17,940	17,760	17,290	17,172	16,713	1° 3'
MF	18 x 1,5	18,000	17,850	17,026	16,936	16,160	17,968	17,732	16,994	16,854	16,128	17,933	17,697	16,959	16,819	16,093	1° 36'
MF	18 x 2	18,000	17,820	16,701	16,601	15,546	17,962	17,682	16,663	16,503	15,508	17,929	17,649	16,630	16,470	15,475	2° 10'
MF	20 x 1	20,000	19,888	19,350	19,275	18,773	19,974	19,794	19,324	19,206	18,747	19,940	19,760	19,290	19,172	18,713	0° 56'
MF	20 x 1,5	20,000	19,850	19,026	18,936	18,160	19,968	19,732	18,994	18,854	18,128	19,933	19,697	18,959	18,819	18,093	1° 26'
MF	20 x 2	20,000	19,820	18,701	18,601	17,546	19,962	19,682	18,663	18,503	17,508	19,929	19,649	18,630	18,470	17,475	1° 57'
MF	22 x 1	22,000	21,888	21,350	21,275	20,773	21,974	21,794	21,324	21,206	20,747	21,940	21,760	21,290	21,172	20,713	0° 51'
MF	22 x 1,5	22,000	21,850	21,026	20,936	20,160	21,968	21,732	20,994	20,854	20,128	21,933	21,697	20,959	20,819	20,093	1° 18'
MF	22 x 2	22,000	21,820	20,701	20,601	19,546	21,962	21,682	20,663	20,503	19,508	21,929	21,649	20,630	20,470	19,475	1° 45'

Example of a bolt thread designation (tolerance centre): M 16 - 6g
Example of a bolt left-hand thread designation (tolerance centre): M 16 - 6g-LH

Thread- Nominal Ø	pitch P	Tolerance field (mm)															Lead
		4 h					6 g					6 e					
		d		d_2		d_3	d		d_2		d_3	d		d_2		d_3	β
		max.	min.	max.	min.	max.	max.	min.	max.	min.	max.	max.	min.	max.	min.	max.	Deg., min.
MF 24 x 1		24,000	23,888	23,350	23,270	22,773	23,974	23,794	23,324	23,199	22,747	23,940	23,760	23,290	23,165	22,713	0° 47'
MF 24 x 1,5		24,000	23,850	23,026	22,931	22,160	23,968	23,732	22,994	22,844	22,128	23,933	23,697	22,959	22,809	22,093	1° 11'
MF 24 x 2		24,000	23,820	22,701	22,595	21,546	23,962	23,682	22,663	22,493	21,508	23,929	23,649	22,630	22,460	21,475	1° 36'
MF 27 x 1		27,000	26,888	26,350	26,270	25,773	26,974	26,794	26,234	26,199	25,747	26,940	26,760	26,290	26,165	25,173	0° 41'
MF 27 x 1,5		27,000	26,850	26,026	25,931	25,160	26,968	26,732	25,994	25,844	25,128	26,933	26,697	25,959	25,809	25,093	1° 3'
MF 27 x 2		27,000	26,820	25,701	25,595	24,546	26,962	26,682	25,663	25,493	24,508	26,929	26,649	25,630	25,460	24,475	1° 25'
MF 30 x 1		30,000	29,888	29,350	29,270	28,773	29,974	29,794	29,324	29,199	28,747	29,940	29,760	29,290	29,165	28,713	0° 37'
MF 30 x 1,5		30,000	29,850	29,026	28,931	28,160	29,968	29,732	28,994	28,844	28,128	29,933	29,967	28,959	28,809	28,093	0° 56'
MF 30 x 2		30,000	29,820	28,701	28,595	27,546	29,962	29,682	28,663	28,493	27,508	29,929	29,649	28,630	28,460	27,475	1° 16'
MF 30 x 3		30,000	29,764	28,051	27,926	26,319	29,952	29,577	28,003	27,803	26,271	29,915	29,540	27,966	27,766	26,234	1° 57'
MF 33 x 1,5		33,000	32,850	32,026	31,931	31,160	32,968	32,732	31,994	31,844	31,128	32,933	32,697	31,959	31,809	31,093	0° 51'
MF 33 x 2		33,000	32,820	31,701	31,595	30,546	32,962	32,682	31,663	31,493	30,508	32,929	32,649	31,630	31,460	30,475	1° 9'
MF 33 x 3		33,000	32,764	31,051	30,926	29,319	32,952	32,577	31,003	30,803	29,271	32,915	32,540	30,966	30,766	29,234	1° 45'
MF 36 x 1,5		36,000	35,850	35,026	34,931	34,160	35,968	35,732	34,994	34,844	34,128	35,933	35,697	34,959	34,809	34,093	0° 47'
MF 36 x 2		36,000	35,820	34,701	34,595	33,546	35,962	35,682	34,663	34,493	33,508	35,929	35,649	34,630	34,460	33,475	1° 3'
MF 36 x 3		36,000	35,764	34,051	33,926	32,319	35,952	35,577	34,003	33,803	32,271	35,915	35,540	33,966	33,766	32,234	1° 36'
MF 39 x 1,5		39,000	38,850	38,026	37,931	37,160	38,968	38,732	37,994	37,844	37,128	38,933	38,697	37,959	37,809	37,092	0° 43'
MF 39 x 2		39,000	38,820	37,701	37,595	36,546	38,962	38,682	37,663	37,493	36,508	38,929	38,649	37,630	37,460	36,475	0° 58'
MF 39 x 3		39,000	38,764	37,051	36,926	35,319	38,952	38,577	37,003	36,803	35,271	38,915	38,540	36,966	36,766	35,234	1° 28'
MF 42 x 1,5		42,000	41,850	41,026	40,931	40,160	41,968	41,732	40,994	40,844	40,128	41,933	41,697	40,959	40,809	40,093	0° 40'
MF 42 x 2		42,000	41,820	40,701	40,595	39,546	41,962	41,682	40,663	40,493	39,508	41,929	41,649	40,630	40,460	39,475	0° 53'
MF 42 x 3		42,000	41,764	40,051	39,926	38,319	41,952	41,577	40,003	39,803	38,271	41,915	41,540	39,966	39,766	38,234	1° 22'
MF 42 x 4		42,000	41,700	39,402	39,262	37,093	41,940	41,465	39,342	39,118	37,033	41,905	41,430	39,307	39,083	36,998	1° 51'
MF 45 x 1,5		45,000	44,850	44,026	43,931	43,160	44,968	44,732	43,994	43,844	43,128	44,933	44,697	43,959	43,809	43,093	0° 37'
MF 45 x 2		45,000	44,820	43,701	43,595	42,546	44,962	44,682	43,663	43,493	42,508	44,929	44,649	43,630	43,460	42,475	0° 50'
MF 45 x 3		45,000	44,764	43,051	42,926	41,319	44,952	44,577	43,003	42,803	41,271	44,915	44,540	42,966	42,766	41,234	1° 16'
MF 45 x 4		45,000	44,700	42,402	42,262	40,093	44,940	44,465	42,342	42,118	40,033	44,905	44,430	42,307	42,083	39,998	1° 43'
MF 48 x 1,5		48,000	47,850	47,026	46,926	46,160	47,968	47,732	46,994	46,834	46,128	47,933	47,697	46,959	46,799	46,093	0° 35'
MF 48 x 2		48,000	47,820	46,701	46,589	45,546	47,962	47,682	46,663	46,483	45,508	47,929	47,649	46,630	46,450	45,475	0° 47'
MF 48 x 3		48,000	47,764	46,051	45,919	44,319	47,952	47,577	46,003	45,791	44,271	47,915	47,540	45,966	45,754	44,234	1° 11'
MF 48 x 4		48,000	47,700	45,402	45,252	43,903	47,940	47,465	45,342	45,106	43,033	47,905	47,430	45,307	45,071	42,998	1° 36'
MF 52 x 1,5		52,000	51,850	51,026	50,926	50,160	51,968	51,732	50,994	50,834	50,128	51,933	51,697	50,959	50,799	50,093	0° 32'
MF 52 x 2		52,000	51,820	50,701	50,589	49,546	51,962	51,682	50,663	50,483	49,508	51,929	51,649	50,630	50,450	49,475	0° 43'
MF 52 x 3		52,000	51,764	50,051	49,919	48,319	51,952	51,577	50,003	49,791	48,271	51,915	51,540	49,966	49,754	48,234	1° 5'
MF 52 x 4		52,000	51,700	49,402	49,252	47,093	51,940	51,465	48,342	49,106	47,033	51,905	51,430	49,307	49,071	46,998	1° 28'
MF 56 x 1,5		56,000	55,850	55,026	54,926	54,160	55,968	55,732	54,994	54,834	54,128	55,933	55,697	54,959	54,799	54,093	0° 29'
MF 56 x 2		56,000	55,820	54,701	54,589	53,546	55,962	55,682	54,663	54,483	53,508	55,929	55,649	54,630	54,450	53,475	0° 40'
MF 56 x 3		56,000	55,764	54,051	53,919	52,319	55,952	55,577	54,003	53,791	52,271	55,915	55,540	53,966	53,754	52,234	1°
MF 56 x 4		56,000	55,700	53,402	53,252	51,093	55,940	55,465	53,342	53,106	51,033	55,905	55,430	53,307	53,071	50,998	1° 22'
MF 60 x 1,5		60,000	59,850	59,026	58,026	58,160	59,968	59,732	58,994	58,834	58,128	59,933	59,697	58,959	58,799	58,093	0° 28'
MF 60 x 2		60,000	59,820	58,701	58,589	57,546	59,962	59,682	58,663	58,483	57,508	59,929	59,649	58,630	58,450	57,475	0° 37'
MF 60 x 3		60,000	59,764	58,051	57,919	56,319	59,952	59,577	58,003	57,791	56,271	59,915	59,540	57,966	57,754	56,234	0° 56'
MF 60 x 4		60,000	59,700	57,402	57,252	55,093	59,940	59,465	57,342	57,106	55,033	59,905	59,430	57,307	57,701	54,998	1° 16'
MF 64 x 2		64,000	63,820	62,701	62,589	61,546	63,962	63,682	62,663	62,483	61,508	63,929	63,649	62,630	62,450	61,475	0° 35'
MF 64 x 3		64,000	63,764	62,051	61,919	60,319	63,952	63,577	62,003	61,791	60,271	63,915	63,540	61,966	61,754	60,234	0° 53'
MF 64 x 4		64,000	63,700	61,402	61,252	59,093	63,940	63,465	61,342	61,106	59,033	63,905	63,430	61,307	61,071	58,998	1° 11'
MF 68 x 2		68,000	67,820	66,701	66,589	65,546	67,962	67,682	66,663	66,483	65,508	67,929	67,649	66,630	66,450	65,475	0° 32'
MF 68 x 3		68,000	67,764	66,051	65,919	64,319	67,952	67,577	66,033	65,791	64,271	67,915	67,540	65,966	65,754	64,234	0° 49'
MF 68 x 4		68,000	67,700	65,402	65,252	63,093	67,940	67,465	65,342	65,106	63,033	67,905	67,430	65,307	65,071	62,998	1° 7'
MF 72 x 2		72,000	71,820	70,701	70,589	69,546	71,962	71,682	70,663	70,483	69,508	71,929	71,649	70,630	70,450	69,475	0° 31'
MF 72 x 3		72,000	71,764	70,051	69,919	68,319	71,952	71,577	70,003	69,791	68,271	71,915	71,540	69,966	69,754	68,234	0° 47'
MF 72 x 4		72,000	71,700	69,402	69,252	67,093	71,940	71,465	69,342	69,106	67,033	71,905	71,430	69,307	69,701	66,998	1° 3'
MF 72 x 6		72,000	71,625	68,103	67,923	64,639	71,920	71,320	68,023	67,743	64,559	71,882	71,282	67,985	67,705	64,521	1° 36'

Example of a bolt thread designation (tolerance centre): M 16 - 6g
Example of a bolt left-hand thread designation (tolerance centre): M 16 - 6g-LH

Metric ISO fine threads

Thread Nominal Ø	pitch P	Tolerance field (mm) 4 h d max.	4 h d min.	4 h d_2 max.	4 h d_2 min.	4 h d_3 max.	6 g d max.	6 g d min.	6 g d_2 max.	6 g d_2 min.	6 g d_3 max.	6 e d max.	6 e d min.	6 e d_2 max.	6 e d_2 min.	6 e d_3 max.	Lead β Deg., min.
MF 76	x 3	76,000	75,764	74,051	73,919	72,319	75,952	75,577	74,003	73,791	72,271	75,915	75,540	73,966	73,754	72,234	0° 44'
MF 76	x 4	76,000	75,700	73,402	73,252	71,093	75,940	75,465	73,342	73,106	71,033	75,905	75,430	73,307	73,071	70,998	0° 59'
MF 76	x 6	76,000	75,625	72,103	71,923	68,639	75,920	75,320	72,023	71,743	75,882	68,559	75,282	71,985	71,705	68,521	1° 31'
MF 80	x 2	80,000	79,820	78,701	78,589	77,546	79,962	79,682	78,663	78,483	77,508	79,929	79,649	78,630	78,450	77,475	0° 27'
MF 80	x 3	80,000	79,764	78,051	77,919	76,319	79,952	79,577	78,003	77,791	76,271	79,915	79,540	77,966	77,754	76,234	0° 42'
MF 80	x 4	80,000	79,700	77,402	77,252	75,093	79,940	79,465	77,342	77,106	75,033	79,905	79,430	77,307	77,071	74,998	0° 56'
MF 80	x 6	80,000	79,625	76,103	75,923	77,639	79,920	79,320	76,023	75,743	72,559	79,882	79,282	75,985	75,705	72,521	1° 26'
MF 85	x 2	85,000	84,820	83,701	83,589	82,546	84,962	84,682	83,663	83,483	82,508	84,929	84,649	83,630	83,450	82,475	0° 26'
MF 85	x 3	85,000	84,764	83,051	82,919	81,319	84,952	84,577	83,003	82,791	81,271	84,195	84,540	82,966	82,754	81,234	0° 39'
MF 85	x 4	85,000	84,700	82,402	82,252	80,093	84,940	84,465	82,342	82,106	80,033	84,905	84,430	82,307	82,071	79,998	0° 53'
MF 85	x 6	85,000	84,625	81,103	80,923	77,639	84,920	84,320	81,023	80,743	77,559	84,882	84,282	80,985	80,705	77,521	1° 21'
MF 90	x 2	90,000	89,820	88,701	88,589	87,546	89,962	89,682	88,663	88,483	87,508	89,929	89,649	88,630	88,450	87,475	0° 24'
MF 90	x 3	90,000	89,764	88,051	87,919	86,319	89,952	89,577	88,003	87,791	86,271	89,915	89,540	87,966	87,754	86,234	0° 37'
MF 90	x 4	90,000	89,700	87,402	87,252	85,093	89,940	89,465	87,243	87,106	85,033	89,905	89,430	87,307	87,071	84,998	0° 50'
MF 90	x 6	90,000	89,625	86,103	85,923	82,639	89,920	89,320	86,023	85,743	82,559	89,882	89,282	85,985	85,705	82,521	1° 16'
MF 95	x 2	95,000	94,820	93,701	93,583	92,546	94,962	94,682	93,663	93,473	92,508	94,929	94,649	93,630	93,440	92,475	0° 23'
MF 95	x 3	95,000	94,764	93,051	92,911	91,319	94,952	94,577	93,003	92,779	91,271	94,915	94,540	92,966	92,742	91,234	0° 35'
MF 95	x 4	95,000	94,700	94,402	92,242	90,093	94,490	94,465	92,342	92,092	90,033	94,905	94,430	92,307	92,057	89,998	0° 47'
MF 95	x 6	95,000	94,625	91,103	90,913	87,639	94,920	94,320	91,023	90,723	87,559	94,882	94,282	90,985	90,685	87,521	1° 12'
MF 100	x 2	100,000	99,820	98,701	98,583	97,546	99,962	99,682	98,663	98,473	97,508	99,929	99,649	98,630	98,440	97,475	0° 23'
MF 100	x 3	100,000	99,764	98,051	97,911	96,319	99,952	99,577	98,003	97,779	96,271	99,915	99,540	97,966	97,742	96,234	0° 53'
MF 100	x 4	100,000	99,700	97,402	97,242	95,093	99,940	99,465	97,342	97,092	95,033	99,905	99,430	97,307	97,057	94,998	0° 45'
MF 100	x 6	100,000	99,625	96,103	95,913	92,639	99,920	99,320	96,023	95,723	92,559	99,882	99,282	95,985	95,685	95,521	1° 8'

Example of a bolt thread designation (tolerance centre): M 16 - 6g
Example of a bolt left-hand thread designation (tolerance centre): M 16 - 6g-LH

Rolling speeds

Blank diameter	Rolling speed ft./min.										
	20	25	30	35	40	50	60	70	80	90	100
	Component rotating at r.p.m.										
1	6400	8000	9600	11150	12750	16000	19200	22300	25500	29000	32000
2	3200	4000	4800	5600	6400	8000	9600	11200	12800	14400	16000
3	2150	2700	3200	3750	4250	5350	6400	7500	8500	9600	10650
4	1600	2000	2400	2800	3200	4000	4800	5600	6400	7200	8000
5	1300	1600	1950	2250	2600	3250	3900	4500	5150	5800	6420
6	1100	1330	1600	1875	2150	2700	3200	3750	4300	4800	5350
7	950	1150	1400	1600	1850	2300	2750	3200	3650	4120	4600
8	800	1000	1200	1400	1600	2000	2400	2800	3200	3600	4000
9	720	900	1100	1250	1450	1800	2150	2500	2850	3200	3550
10	640	800	1000	1200	1300	1600	1950	2250	2600	2900	3200
12	540	700	800	950	1100	1350	1600	1900	2150	2430	2700
14	450	600	700	800	950	1150	1400	1600	1850	2100	2300
15	430	550	650	750	875	1100	1300	1500	1720	1950	2150
16	410	510	600	700	800	1000	1200	1400	1600	1800	2000
18	369	450	540	630	720	910	1100	1270	1445	1600	1800
20	320	400	485	560	640	800	800	1130	1300	1450	1620
22	300	375	450	520	600	740	900	1050	1200	1320	1470
24	270	350	420	470	540	675	800	950	1100	1200	1350
25	260	330	400	460	520	640	775	900	1050	1170	1300
26	250	315	390	450	510	630	750	870	1000	1125	1250
28	230	300	350	415	470	590	700	800	920	1030	1150
30	220	270	340	380	435	540	640	760	875	970	1090
32	210	260	320	364	425	530	615	720	800	910	1000
34	190	240	295	340	385	480	570	665	760	855	950
35	185	230	280	330	375	465	550	640	740	835	935
36	180	225	270	315	360	450	540	630	710	800	900
38	170	210	260	300	340	430	510	590	680	760	850
40	160	200	240	285	325	410	485	560	640	720	800
45	145	180	215	255	290	365	435	510	580	650	715
50	130	160	195	225	260	325	390	450	520	590	650
55	120	150	175	205	235	295	350	410	470	530	590
60	110	135	160	190	215	270	325	375	435	490	540
65	100	125	130	175	200	255	305	350	400	450	500
70	95	115	140	160	185	230	275	325	370	420	465
75	90	110	130	150	175	215	260	310	350	390	435
80	85	105	125	145	160	205	250	290	330	370	410
85	80	100	115	135	155	190	230	265	310	340	380
90	75	90	110	125	145	180	215	255	290	325	365
100	70	85	100	115	130	160	195	225	260	300	325

Rolling speeds

In general, the following applies:

- Cone threads may be produced with a higher rolling speed than trapezoidal threads.
- In case of a higher strain σ, the rolling speed is higher than for materials with a smaller strain σ.
- Materials with a higher tensile strength must be rolled with a lower rolling speed.
- For cone threads, we recommend 20 - 80 m/min as a guideline. For trapezoidal and similar threads, we recommend approx. 15 - 30 m/min.

Rolling speed formula:

$$V = \frac{d_2 \cdot \pi \cdot n}{1000} \text{ [m/min]}$$

Sample calculation: M 10 x 1,5 (6 g)
Starting -Ø (flank -Ø) d_2 = 8,99 mm
Workpiece speed n = 1800 U/min

$$V = \frac{8{,}99 \cdot \pi \cdot 1800}{1000} \text{ [m/min]}$$

V = 50,84 m/min

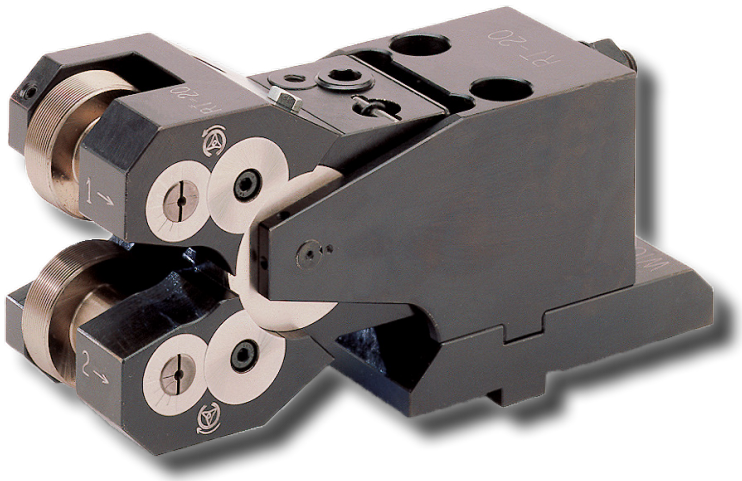
Rotational speed formula:

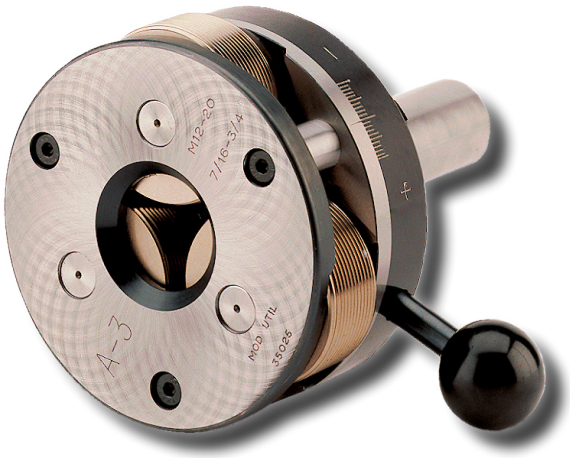
$$n = \frac{1000 \cdot V}{d_2 \cdot \pi} \text{ [min}^{-1}\text{]}$$

Sample calculation: M 10 x 1,5 (6 g)
Starting-Ø (flank-Ø) d_2 = 8,99 mm
Rolling speed V = 51 m/min

$$n = \frac{1000 \cdot 51}{8{,}99 \cdot \pi} \text{ [min}^{-1}\text{]}$$

n = 1805,76 min^{-1}





Material rolling properties

Generally speaking, materials starting from a minimum strain of approx. 5% and a tensile strength of up to approx. 1400 N/mm² may be formed.

Table values

Please refer to the information in the table below for each individual case.
The values listed in the table are guide values only and may vary depending on the rolling head type, the material quality and the machine conditions.
If you require technical support, please contact your Boehlerit customer service representative.

Materials	Material DIN	Material code	Tensile strength N/mm²	Hardness Brinell (HB)	Strain σ min. 5 %	Rolling properties	Rolling speed m/min.
Ferrous metals							
General structural steels	ST 37	1.0120	500	150	28	●●●	40 - 80
	ST 50	1.0531	500 - 600	150 - 190	22	●●●	30 - 60
	ST 60	1.0540	500 - 600	190 - 250	15	●●●	20 - 50
	CK 45	1.1191	650 - 850	200 - 250	15	●●●	20 - 50
Case hardening steel	C 15 E	1.1141	500	150	16	●●●	40 - 70
	16 MNCr 5	1.7131	500 - 850	150 - 200	10	●●	30 - 50
Nitriding steels	34 CrAl 6	1.8504	1000	290	14	●●	20 - 50
	31 CrMo V 9	1.8519	1000 - 1300	290 - 380	11	●●	20 - 40
Free cutting steels	9 S 20	1.0711	360	160	25	●●●	30 - 60
	9 S Mn Pb 28	1.0718	380	170	23	●●●	30 - 60
	35 S 20	1.0726	500 600	190	18	●●●	30 - 60
Heat treatable steels	C 35	1.0501	700	200	18	●●●	40 - 70
	CK 60	1.1221	700 - 900	200 - 260	14	●●	30 - 60
	42 CrMo 4	1.7225	900 - 1200	260 - 350	11	●●	20 - 50
	30 CrMo V 9	1.7707	1200 - 1400	350 - 400	9	●	20 - 40
	34 CrNiMo 6	1.6582	1000 - 1400	350	9	●	20 - 40
Tempered steels	50 CrV 4	1.8159	900 - 1000	250	10	●	20 - 40

Rolling properties:

●●● Good rolling properties

●● Can be rolled

● Limited rolling properties

Material rolling properties

Materials	Material DIN	Material code	Tensile strength N/mm²	Hardness Brinell (HB)	Strain σ min. 5 %	Rolling properties	Rolling speed m/min.
Ferrous steels							
Tool steels	X 210 Cr 12	1.2080	800	230		●●	30 - 50
	X 130 W 5	1.2453	800 - 1000	230 - 290	9	●●	20 - 40
	115 CrV 3	1.2210	600 - 700	220	10	●●	30 - 50
High speed steels	S 6-5-2 (DM 05)	1.3343	850 - 900	240 - 300		●	20 - 40
	S 6-5-2-5 (E Mo 5 Co5)	1.3243	850 - 900	240 - 300		●	20 - 40
Stainless steels	X 10 Cr 13	1.4006	550 - 650	200 - 250	18	●●	30 - 50
	X 22 CrNi 17	1.4057	800 - 900	250 - 320	12	●●	30 - 50
	X 12 CrMoS 17	1.4104	500 - 800	200 - 250	20	●●	30 - 50
	X 5 CrNi 1810	1.4301	500 - 700	200 - 250	50	●●●	35 - 55
	X 10 CrNiS 189	1.4305	500 - 700	200 - 250	50	●●●	35 - 55
	X5CrNiMo 17122	1.4401	500 - 700	200 - 250	30	●●	30 - 50
	X6CrNiMoTi 17122	1.4571	500 - 700	200 - 250	40	●●	30 - 50
Cast steels	GS 38	1.0416	500	150	20	●●●	40 - 60
	GS 36 Mn 5	1.5067	500 - 600	150 - 200	17	●●●	40 - 60
	GS 50 CrMo 4	1.7228	650	200	11	●●	30 - 50
Malleable cast iron	GTS 45		450 - 500	150 - 200	6	●●	30 - 60
	GTS 65		600 - 700	210 - 250	6	●●	30 - 60
Cast iron	GGG 40	0.7040	400 - 500	140 - 180	27 - 15	●●●	30 - 60
	GGG 50	0.7050	500 - 600	180 - 210	12	●●	30 - 50
	GGG 60	0.7060	600 - 750	210 - 250	8	●●	30-50
High temperature steels	NiCr 20 Co 19	Nimonic 263	540 - 700	160 - 200		●●	30 - 50
	NiCr 17 Mo 17 FeW	Hasteloy	700 - 900	200 - 260		●●	20 - 40
Nickel alloys		Inconell 600	900 - 1100	260 - 330		●	20 - 40
Non-ferrous metals							
Copper	C-CU (F 20)	2.0120	ca. 200	40 - 65	ca. 30	●●●	40 - 100
	E-Cu (F 25)	2.0060	250	65 - 90	ca. 8	●●●	40 - 80
Copper alloys (Brass)	MS 63 (F 30)	2.0320.10	300	ca. 70	40	●●●	40 - 80
	MS 60 Pb (F 41)	2.0370.26	400	ca. 100	15	●●	40 - 70
	MS 60 Pb (F 35)	2.0372.10	340	ca. 90	35	●●●	40 - 70
	MS 58 F 44	2.0380.26	430	ca. 125	19	●●	40 - 70
	M 58 F 44	2.0401.10	430	ca. 125	19	●●	40 - 70
Zinc alloys	ZnCu 1	3.3525	180 - 200	40 - 60	15-4	●●●	40 - 70
Aluminium alloys	AlMg 2	3.2315	150 - 210	40 - 60	15-4	●●●	40 - 70
	AlMgSi 1	3.4355	200 - 320	60 - 95	14-9	●●	40 - 70
	AlZnMg 3	3.1355	400 - 450	105 - 125	10-5	●	30 - 50
	AlCuMg 2	3.4365	450	115	9	●●	30 - 50
	AlZnMgCu 1,5	3.7035	530 - 540	140	7	●●	30 - 50
Titanium alloys	Ti 99,7	3.7124	290 - 550	85 - 160	ca. 22	●●●	30 - 60
	TiCu 2,5	3.7115	550 - 750	160 - 220	ca. 20	●●●	30 - 60
	TiAl 15 Sn 2	3.7164.7	750 - 950	220 - 280	ca. 10	●●	30 - 60
	TiAl 7 Mo		1030 - 1100			●●	20 - 40

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