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## FIGURE 3. STANDARD DIE PROFILE AND TWO DIES DESIGNED TO ELIMINATE CRACKING IN BRITTLE MATERIALS

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	Die <sup>(a)</sup>	Extrusion Ratio	Stem Speed, ipm	Extrusion Pressure, 1000 psi				Type of	Length of	Cracks(b)	
Objective or Trial Variable				Breakthrough		Runout		Curve,	Extrusion,	Circum-	Longi-
				Stem	Fluid	Stem	Fluid	p 25	inch	ferential	tudinal
			Wro	ught TZM	1 - Stress	Relieved				2918	000 000000
Reference	А	2•5	6	157	141	142	129	B1	4	None	3
Die design	В	4	6	280	242			B4	1	None	None
Die design	D	4	• 6	252	218	205	183	B1	5	Nose only	4
Temperature	С	4	6	1.				12.47	1142.	Die seal leak	
Temperature	D	4	6	178	166	171	159	B2	7	None	None
Wrought TZM - Recrystallized						d					
Die design	с	4	20	198	176	194	168	BI	12	None	None
				Beryllium	- Powde	r Origin					
Die design	С	4	20	234	205	228	200	B1	10	None	None
Temperature	D	4	20	150	140	143	133	B1	14	Numerous	Numerous
	Objective or Variable Reference Die design Die design Die design Die design Die design	Objective or VariableDie(a)ReferenceADie designBDie designDTemperatureCDie designCDie designCDie designC	Objective or VariableExtrusion RatioReferenceA2.5Die designB4Die designD4TemperatureC4Die designC4Die designD4	Objective or Variable Extrusion Die <sup>(a)</sup> Speed, Ratio Speed, ipm   Wro   Reference A 2.5 6   Die design B 4 6   Die design D 4 6   Temperature C 4 6   Die design C 4 20   Die design C 4 20   Die design C 4 20	Objective or VariableExtrusion Die(a)Speed, RatioBreakt ipmWrought TZMReferenceA2*56157Die designB46280Die designD46252TemperatureC46Die designC46178Die designC420198Die designC420150	Objective or VariableExtrusion Die(a)Speed, RatioBreakthrough ipmWrought TZM - StressReferenceA $2^{\circ}5$ 6157141Die designB46280242Die designD46252218TemperatureC46Die designC420198176Die designC420198176Die designC420150140	Objective or VariableExtrusion Die(a)Speed, RatioBreakthrough StemRun StemWrought TZM - Stress RelievedReferenceA $2 \cdot 5$ 6157141142Die designB46280242Die designD46252218205TemperatureC46TemperatureD46178166171Die designC420198176194Die designC420198176194Die designC420150140143	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Objective or VariableExtrusion Die $(a)$ Speed, RatioBreakthrough stemRunout StemCurve, FluidExtrusion, p 25Circum- ferentialWrought TZM - Stress RelievedReference Die designA2°56157141142129B14NoneDie designB46280242B41NoneDie designD46252218205183B15Nose onlyTemperatureC46Die seaDie designC420198176194168B112NoneBeryllium – Powder OriginDie designC420234205228200B110NoneDie designC420234205228200B114None

## TABLE 4. EXPERIMENTAL DATA FOR HYDROSTATIC EXTRUSION OF TZM MOLYBDENUM ALLOY AND BERYLLIUM

Die angle – 45 degrees (included) Fluid – Castor oi<sup>1</sup> Billet lubricant – L38

(a) See table on p 14 for double reduction die details.

(b) Cracks occurred on the nose only when extruding through die with space between bearings.

(c) 500 F extrusion using polyphenyl ether (PPE) as the fluid medium. Fluid pressures estimated from stem pressures. High-temperature high-pressure gage out of order.