

# BOHLER S693/S692 MICROCLEAN<sup>®</sup>

## High Performance PM M4 - High Speed Steel

	Vacuum	Salt Bath** / Fluidized Bed	Atmosphere Furnace Muffle Furnace / Packed																																							
	** Salt Bath heat treatment can be performed but is not recommended for details with blind holes or threaded holes that will not be reworked after heat treatment.																																									
<b>Preheating Temperature</b>	1. Bring up to 1200°F, equalize 2. Heat up to 1550°F, equalize	1. 1100 – 1200°F, equalize 2. 1500 – 1600°F, equalize	1. Bring up to 1200°F, equalize 2. Heat up to 1550°F, equalize																																							
<b>Hardening Temperature (Austenitizing)</b>	1875 – 2125°F <sup>†</sup>																																									
<sup>†</sup> For tools with a wall thickness of 1 ½" and greater, use a higher austenitizing temperature than listed in the chart to achieve the state and hardness.	Holding times after the tool or part has fully heated through at the hardening temperature:  2000°F 20 min 2100°F 15 min	Immersion time after preheating:  1975°F 12 min 2050°F 8 min	Holding times after the tool or part has fully heated through at the hardening temperature:  2000°F 20 min 2100°F 15 min																																							
<b>Quenching</b> *	<b>Alt. 1</b> Inert gas, positive pressure <b>Alt. 2</b> Back-filled pressurized gas to 1000°F, then equalize center and surface. Then cool in circulating air.	<b>Alt. 1</b> Interrupted salt or oil equalized at 1000°F, cool in air <b>Alt. 2</b> Forced air circulation	<b>Alt. 1</b> Circulated inert gas <b>Alt. 2</b> Circulated air																																							
	*Cooling rate must be adequate to avoid any transformation, with decreased properties as a result. However, also consider the risk of excessive distortion from very fast cooling. *For maximum dimensional stability, a cryogenic treatment can be applied immediately after quench. An increase in hardness may occur. However, avoid intricate shapes due to risk of cracking.																																									
<b>Tempering</b> <sup>††</sup>  (minimum two times)  Temper immediately after quenching when the tool or part reaches 150°F (See data sheet for additional guidelines)	<table border="1"> <thead> <tr> <th rowspan="2"><u>Tempering Temperature</u></th> <th colspan="4"><u>Hardening Temperature and Hardness</u></th> </tr> <tr> <th colspan="2"><u>Vacuum/Atmosphere</u></th> <th colspan="2"><u>Salt</u></th> </tr> <tr> <td></td> <td><u>2000°F</u></td> <td><u>2100°F</u></td> <td><u>1975°F</u></td> <td><u>2050°F</u></td> </tr> <tr> <td>1020°F</td> <td>59-61 HRC</td> <td>61-63 HRC</td> <td>59-61 HRC</td> <td>61-63 HRC</td> </tr> <tr> <td>1040°F</td> <td>58-60 HRC</td> <td>60-62 HRC</td> <td>58-60 HRC</td> <td>60-62 HRC</td> </tr> </thead> <tbody> <tr> <td colspan="5"><b>A minimum temper of 1000°F is recommended.</b></td> </tr> <tr> <td colspan="5">Tempering Times: One hour per inch of wall thickness or for a minimum of 2 hour once tool comes to temperature.</td> </tr> <tr> <td colspan="5"><sup>††</sup>Minimum of two tempers required except when using a hardening temperature above 2000°F, then temper a minimum of three times.</td> </tr> </tbody> </table>		<u>Tempering Temperature</u>	<u>Hardening Temperature and Hardness</u>				<u>Vacuum/Atmosphere</u>		<u>Salt</u>			<u>2000°F</u>	<u>2100°F</u>	<u>1975°F</u>	<u>2050°F</u>	1020°F	59-61 HRC	61-63 HRC	59-61 HRC	61-63 HRC	1040°F	58-60 HRC	60-62 HRC	58-60 HRC	60-62 HRC	<b>A minimum temper of 1000°F is recommended.</b>					Tempering Times: One hour per inch of wall thickness or for a minimum of 2 hour once tool comes to temperature.					<sup>††</sup> Minimum of two tempers required except when using a hardening temperature above 2000°F, then temper a minimum of three times.					
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<b>Stress Temper performed on hardened tools after EDM, welding or during preventative maintenance</b>	Check hardness to confirm tool status. Temperature: Shall be 50°F below the lowest tempering temperature.  Time: Soak 30 minutes per inch of maximum section with a minimum of 2 hour once tool comes to temperature. Cool in still air.																																									
<b>Dimensional Stability</b>	Average size change as a result of hardening and tempering may not exceed 0.003 inch/inch/maximum dimension if the tool has been stress relieved before finish machining.  If stress relieving is not performed as recommended, dimensional stability may be inconsistent and cannot be guaranteed.																																									

### Characteristics

- Very good wear resistance and edge retention
- Very good compressive strength
- Good toughness for long-running applications

This information is based on our present state of knowledge and is intended to provide general notes on our products and their uses. It should not therefore be construed as a warranty of specific properties of the products described or a warranty for fitness for a particular purpose. It is your responsibility to confirm you have the latest revision of this document (verify on our website) and that you forward to your Heat Treatment service provider. Failure to do so may result in inferior material properties. Revision Date: January 18 2017