

1960s	→	1970s	→	1980s	→	1990s	→	2000 & beyond
Process Development Begins		Process Introduction to Industry		Process Limitations Uncovered		Process Solutions Found		AvaC® Production Carburizing
R&D activities focus on finding alternatives to atmosphere gas carburizing.		Ultra-high-pressure carburizing techniques developed using natural gas, 100-percent methane and propane.		R&D activities focus on methods to reduce carburizing pressure, as well as investigating gas pressure quenching as an alternative to oil quenching.		R&D activities focus on finding a solution to excessive soot and tar formation by using acetylene and equipment designed specifically for low-pressure carburizing.		Combination of low-pressure carburizing equipment designs using acetylene achieve production vacuum carburizing with 95+ percent up-time reliability.
First vacuum carburizing patents issued.		Various vacuum carburizing method patents issued.		High maintenance and low up-time due to excessive soot from propane use halts commercialization.		Patents issued on use of low-pressure carburizing with acetylene.		Production loads are heavy, dense and include all types of part geometry in all industries.
Production loads are light, open and simple geometry.		Production loads are heavier, denser and include both simple and complex geometries.		Lower carburizing pressures and various gas introduction methods are adopted to attempt to reduce soot formation.		Combination of low-pressure carburizing with acetylene as the carburizing gas eliminates soot and tar formation (a concern in vacuum carburizing).		Modular-designed batch, semi-continuous and continuous vacuum carburizing furnaces become integrated into manufacturing and become a viable alternative to the use of atmosphere furnaces.
Limitations of existing vacuum equipment identified.		Equipment limitations improve with the introduction of new vacuum integral oil quench batch equipment.		Plasma carburizing becomes a popular alternative to vacuum carburizing.		Industry confidence and process credibility concerns addressed.		Changes in material chemistry make gas quenching an economical alternative to oil quenching.