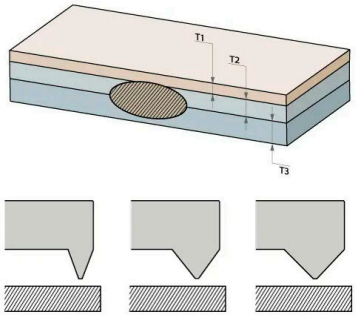
Guidelines for
Root Cause Analysis of Resistance Welding Problems

Based on systematic studies of resistance welding problems in lab tests and industry applications, we have determined that all root causes can be classified into three categories: design factors, process settings and dynamic issues. These insights and understandings can help solve welding problems more quickly and effectively.

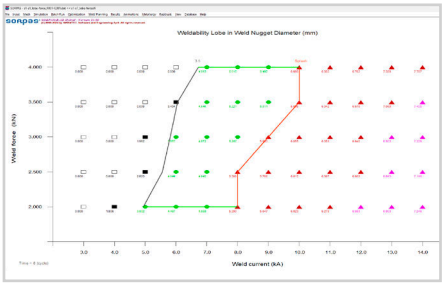
❶ Design Factors ▸ Heat Balance at Weld Interface



The basic principle of resistance welding is to focus heating at the desired weld interface thereby creating a joint between materials.

Electrodes are often made in special shapes with materials of lower resistance, but sometimes also with higher resistance for welding conductive joints. To enhance local heating, a projection or a coating of high resistance may be added on the part of lower resistance. In cases with multiple weld interfaces, such as three-sheet spot welding, more advanced process optimizations may be needed to improve heat distributions. SORPAS® simulations can be used to evaluate weld designs and help to select alternative materials for a better heat balance without physical weld tests.

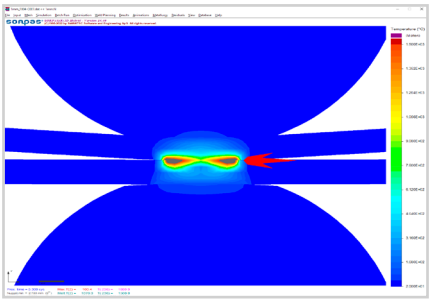
❷ Process Settings ▸ Robustness and Consistency



It is recommended that all welding processes are systematically optimized before production begins. When transferring optimized weld schedules from a lab to a plant or from one plant to another, re-optimizations are needed for new conditions like various materials or machines from different suppliers.

If a weld process started successfully but issues arise after some welds, it may be due to poor process settings. Frequent expulsions indicate the process is running too close to the upper limit of the process window. If cold weld (false weld) occurs, it is running too close to the lower limit. SORPAS® simulations and optimizations with actual production conditions can be used to improve the robustness of production and consistency of weld quality.

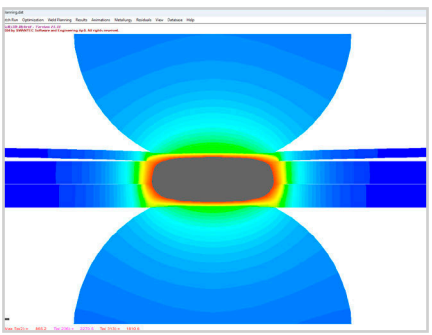
❸ Dynamic Issues ▸ Irregularities and Random Defects



The better the optimizations before welding production, the fewer problems will be encountered during production. It is important to Ensure before welding.

Nonetheless, irregularities and random defects may still happen with poor welds or expulsions. They are likely caused by dynamic issues or poor fit-ups, such as electrode degradation, electrode misalignment, gap between sheets, positioning errors, mounting tolerances, or bad conditions resulted from preceding process, etc. SORPAS® simulations and optimizations can be used to predict results of some dynamic issues and achieve better optimized process settings thus enable predictive production maintenance to prevent related problems.

■ SOLUTIONS by Interactive Correlations and Digital Twins



Resistance welding is a complex dynamic process. Many causes are correlated with dynamic interactions. SORPAS® simulations and optimizations can be used to concurrently improve weld designs and achieve optimal weld process settings. For example, electrode life can be improved by optimizing cooling design and process settings. LME is mainly attributed to materials and coatings, but it can be reduced or even avoided by process optimizations.

With innovations of new sensors and monitoring technologies, more data will be acquired during production and analyzed by machine learning. It will be possible in the future to integrate machine learning with adaptive optimizations by digital twins to automatically rectify or alarm dynamic issues during production.

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