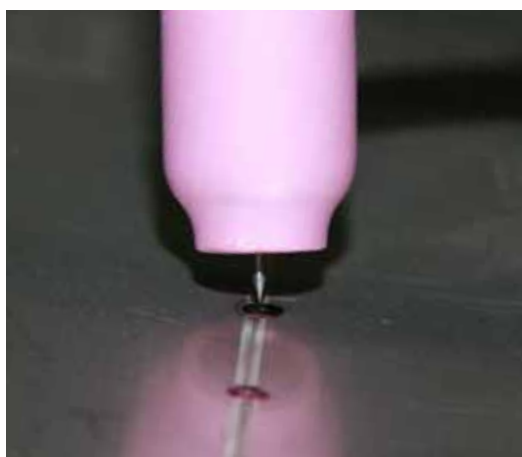


# FIXATION AND TACK WELDING OF AUSTENITIC STAINLESS PIPES



**Damstahl**<sup>®</sup>  
stainless steel solutions

**MICATRONIC**  
WELDING VALUE

# INTRODUCTION

This booklet is the result of a co-operation between Damstahl and Migatronik, two Danish companies in the field of steel processing. Damstahl is a supplier of stainless steel materials and Migatronik is a manufacturer of high-quality welding machines for industrial use.

The booklet describes the methods and results of tack welding/fixation, with or without root protection gas, and recommends best practices for fixating pipes prior to completing the weld, in the food/pharma industry, among others. The booklet serves as a guide for fixation of pipes and fittings in austenitic stainless steel, without root protection gas and filler material, using the semi-automatic TIG-A-Tack process. The materials and requirements described in the booklet are to be considered.

Processes and materials are not exhaustively explained in this booklet which it meant as a dynamic publication that will be updated on a continuing basis. We hope it will inspire to innovative thinking and open your eyes to the possibilities of optimizing fixation of quality pipes and fittings prior to final welding. Careful welding and good workmanship are the conditions for excellent welding results.

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# TACK-WELDING/TIG-A TACK FIXATION OF STAINLESS DAIRY PIPES IN CONSTRUCTION WORKS



Tack-welding with the semi-automatic TIG-A Tack process - called fixation owing to the ultra-small welding spots (Migatron Pi machine) - can be made without root protection gas. This requires correctly set fixation time and fixation current as well as concern for good workmanship. The fixation time (fig. 6.1) for dairy pipes for example should be set from 0.02 to max. 0.1 second, depending on plate thickness. The fixation current should be set at twice or three-fold the welding current used to finish the weld.



## IMPORTANT TIPS FOR TIG-A TACK FIXATION OF DAIRY PIPES OR SIMILAR WORKPIECES IN AUSTENITIC STEEL:

- Workpieces must be clean, without burrs and sharp edges and at right angle to the supporting surface.
- The distance between pipes must be as short as possible and always  $< 0.2$  mm. (In case of large gaps, use conventional tack-welding, a similar procedure with filler material and root protection gas).
- Edge displacement must be avoided because it will reduce the actual plate thickness. Example: 0.4 mm displacement between two  $\varnothing 3$ " dairy pipes will reduce the actual plate thickness from 1.6 mm to 1.2 mm. If edge displacement is unavoidable, the amount of energy (time and current) must be reduced considerably to avoid severe discolouration (fig. 5.3).
- Fixation time: 0.02-0.1 second depending on plate thickness.
- Fixation current: twice to threefold the welding current used to finish the weld.
- TIG-A Tack is only designed for stainless austenitic types of material, such as EN1.4307, 1,4404, AISI 304L, 316L and other non-magnetic cubically face-centered stainless steels.
- The maximum values (time and current) tested on a workpiece must be complied with.

## REQUIREMENTS FOR VISUAL ASSESSMENT AND APPROVAL AFTER TACK-WELDING OR TIG-A TACK FIXATION:

Instructions for visual inspection of the exterior and interior of a pipe, to ensure compliance with all requirements:

- The outside of the tack-welding/fixation must be metallic and comply with the requirements of maximum excess weld material etc.
- The permissible discolouration inside the pipe must be  $< \varnothing 3$  mm.
- Oxidation and blue colouration inside the pipe must be avoided.
- The tack-welding/fixation must be in the middle of the weld.
- After finishing the welding of the pipe, there must be no discolouring resulting from the tack-weld/fixation.
- The welder is responsible for compliance with all requirements.
- The welder is responsible for checking all tack-welds/fixations according to the chosen inspection level, prior to finishing the weld.

## Tack-welding versus fixation!

**Differences:** A tack-welding is carried out manually and is larger than a fixation. A tack-welding increases the heat-input because of the longer weld time, penetrates deeper into the parent material and increases the risk of deformation. Filler material is typically required and root protection gas is always required (cf. DS/EN 1011-1.3). A TIG-A Tack fixation is always carried out with automatic or semi-automatic wel-

ding equipment. Result: small weld spots, low heat-input and less deformation. If carried out correctly, root protection gas is not required.

**Similarities:** Both methods are used for fixing workpieces prior to and during final welding and must be included in an approved WPS.



# WELDERS' SELF-CHECKING OF FIXATIONS ON WELD SIDE AND ROOT SIDE

## PLEASE NOTE!

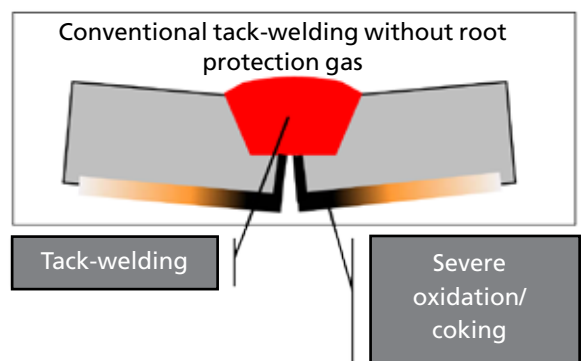
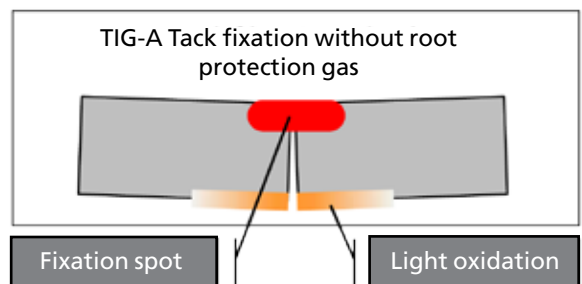
Being based on practical tests, test values and test results are for your guidance only. The extent of discolouration on the root side is always a decisive factor which is why it is important to check continuously that the result of the tack-welding/fixation meets all requirements.

## TESTING A TACK-WELD/FIXATION:

- All workpieces which are to be welded must be tested in terms of pipe size, quality and plate thickness. The testpieces must be approved by the project managers of both buyer and seller and kept for future reference in case of doubt.
- Welder's name, tack-welding time/fixation time and fixation current and test date must appear from the testpiece.
- Testing the workpieces must be carried out by the individual welder. This allows setting time and current for tack-welding/fixation of each individual pipe dimension/plate thickness on welder's own welding machine.
- The welder must at least have access to a mirror and a lamp for check of the root side of tack-welds/fixations.

## BENEFITS OF CORRECTLY CARRIED OUT TIG-A TACK FIXATIONS:

- Less oxidation of root side and weld
- Lower heat-input
- Less deformation of the material
- Lower consumption of time and gas
- A simple process
- Invisible tack points/fixations after finishing the weld
- Suitable prior to finishing the weld (manual, orbital or robot/automated welding)
- Economical



# REFERENCE ATLAS AND TIG-A TACK EXAMPLES

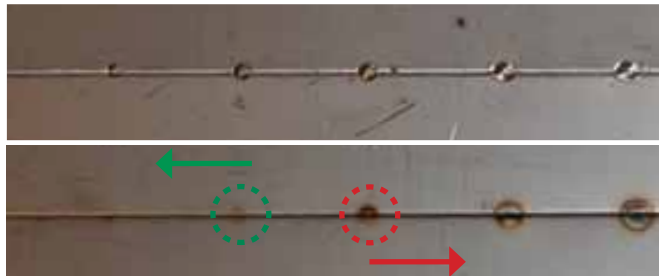


Fig. 5.1

Fig. 5.1: weld side and root side in 1.5 mm plate, fixated without root protection gas as per values in fig. 6.1 (max. 175 A/0.06 second - green circle). Discolouring of root side (green circle) is normally acceptable<sup>1)</sup>. The fixation spot on the weld side must always be metallic

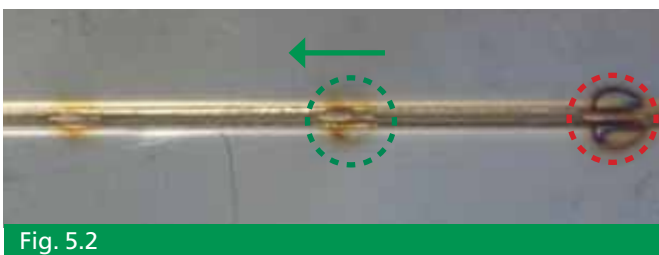


Fig. 5.2

Fig. 5.2: 2 mm plate opened 90 degrees from the root side. The weld below the fixation spot is almost without discoloration (green circle), among other things owing to anodic stripping (no turbulence/new oxygen because of short heating time). The visible rest of discoloration is eliminated during finishing the weld, using root protection gas.

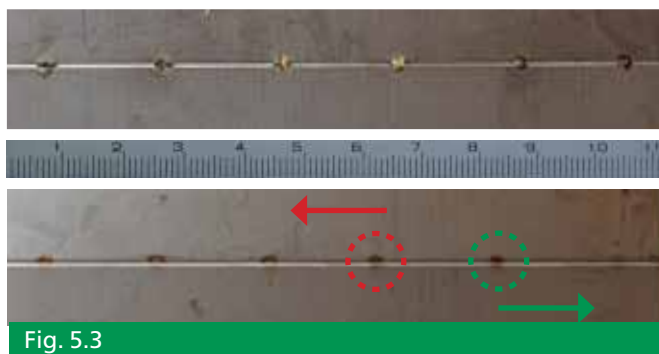


Fig. 5.3

Fig. 5.3: weld side and root side in 1.5 mm plate, fixed with 1.0 mm edge displacement lengthwise to the plate. Discolouring of one of the plates is caused by the "thinner" plate thickness owing to edge displacement. Values cf. fig. 6.1 should be reduced to the "new" plate thickness. (All fixations in the photo are carried out at the same "high" value).

## PLEASE NOTE!

The discolourations are comparable with reference atlas<sup>1)</sup> Charts 1 and 2 level C ( $\approx 100$  ppm. for root protection gas and  $\approx 32$  ppm. for argon) as maximum values. The quality level is to be determined on the basis of the individual assignments.

<sup>1)</sup> FORCE Technology reference atlas available upon request to FORCE Technology, DK-2605 Brøndby.



Fig. 5.4

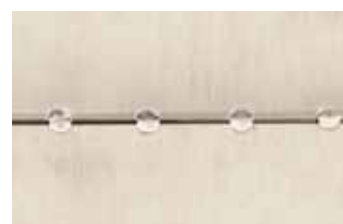


Fig. 5.5

Fig. 5.4: root side in a 3" pipe carried out with TIG-A Tack without use of root protection gas.

Fig. 5.5: root side in a 3" pipe carried out with traditional tack-welding without use of root protection gas. The result is a destroyed and quite unacceptable root side.

## TIG-A Tack fixation sample



Material: stainless 1.4404 (316) 1.5 mm  
Welding gas: Ar/H<sub>2</sub> (98/2) without root protection gas  
Data as per fig. 6.1



# SETTINGS AND GUIDELINES

Fig. 6.1 shows the setting values<sup>2)</sup> of main parameters (current and time) compared to plate thickness of I-welds. To ensure sufficient fixation between pipes, fittings or plates with a minimum of discolouration on root side as a primary result, the welding machine must be set so that values

never go beyond the yellow zone between the green and red fields in the curves. The yellow zone indicates maximum values, for which reason setting the machine towards the middle of the green field is recommended.

## PLEASE NOTE!

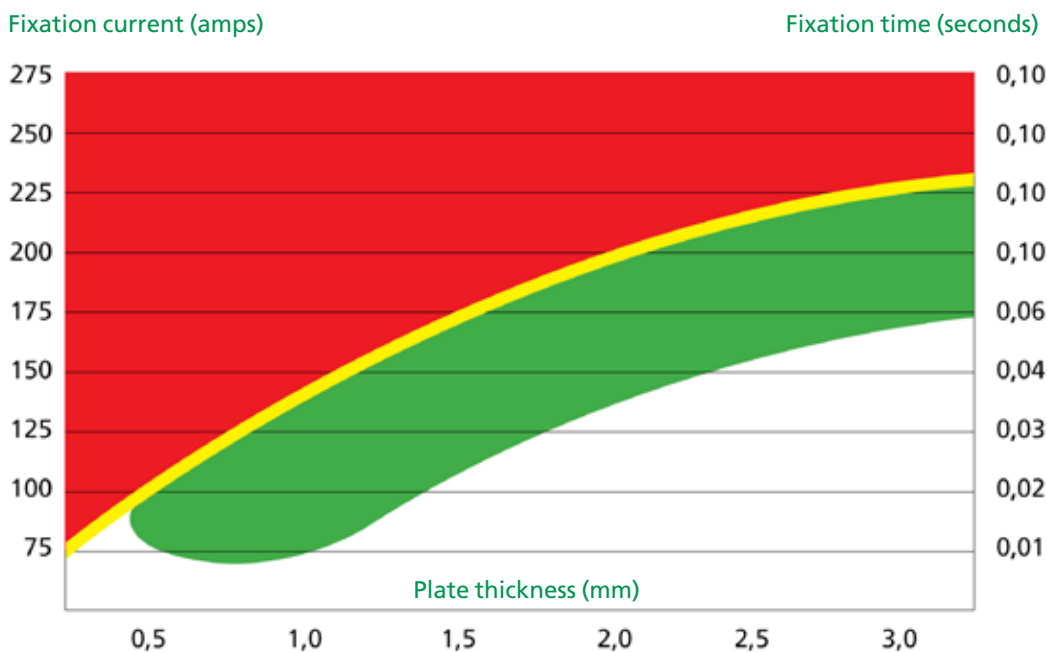
### Setting TIG-A Tack

All values in the green field (fig. 6.1) will give acceptable results under normal circumstances (see page 5). Please regard the values as a guideline and set them according to plate thickness.

## PRACTICAL INFORMATION:

- Hold the TIG torch at right angles in all directions +/- 5 degrees, at 1-2 mm distance to the I-weld for optimal focusing of the discharge energy.
- Grind the tungsten electrode lengthwise with a pointing length of approx. 2.5 times the diameter. Follow the electrode manufacturer's instructions for maximum current load.
- Shielding gas = Argon or Argon/2-3% Hydrogen.

Fig 6.1



<sup>2)</sup> All tests and settings were carried out with a Migatron Pi TIG welding machine featuring TIG-A Tack™. If other makes of welding machines with this function are used, corrections in fixation time/current must be expected. Prior to final fixation on workpieces, tests must be carried out in similar material and approved. Tests must be kept.

# CONVENTIONAL TACK-WELDING FOR OTHER ASSIGNMENTS IN AUSTENITIC STEEL

For some conventional tack-welding assignments, TIG-A Tack fixation should not be carried out, e.g. owing to thick plate thicknesses with V-welds, edge displacement, gap or stainless material groups other than austenitic steel, requiring filler material. Welding machines that do not feature automatic or semi-automatic setting of time and current cannot be used for tack-welding/fixation in the food-/pharma industry without use of root protection gas in pipes.

Unfortunately, many welders cut corners and tack-weld without root protection gas "where it is invisible", typically in pipes! Figures 7.1 and 7.2 show typical examples of mirror checks of pipes that were tack-welded manually without root protection gas and then welded. The effects are defects, discolouring and pores in the finished weld at the tack-weld as well as a risk of corrosion. Unfortunately, poor welds often result in bacteria and their causes and breeding ground can be difficult to find. Troubleshooting and reconstruction of complete pipe/process systems are necessary from time to time. Neither the customer who purchased the finished product nor the welder who performed the welding know the latent risk after several months or years in operation, considering the fact that the plant functioned when delivered. Possible consequential difficulties caused by lack of training or lack of knowledge of difficulties of welding stainless steel and/or lack of self-control, have high costs.

- Tack-weldings shall be specified in approved WPS's and must only be carried out by certified welders.
- Start/stop cracks and other defects must not exceed acceptance criteria and must be repaired (e.g. by grinding) prior to the finishing weld.
- Approved filler materials being used must be clean and dry and of the same or higher alloys to compensate for unavoidable burning of alloy elements in the weld pool. This ensures resistance to corrosion in the whole life of the construction.
- Owing to a high coefficient of expansion and low thermal conductivity, high heat input and large gaps must be avoided to prevent deformation and harmful structural changes in the heat-affected zone (HAZ).

For further information about tack-welding and welding in stainless steel, please refer to the EN 1011-1.3 standard (available from suppliers of standards on request).



Fig. 7.1

Fig. 7.1: Mirror check of a conventional manual tack-weld (not TIG-A Tack), carried out without root protection gas. Result: an unacceptable root side.



Fig. 7.2

Fig. 7.2: The result of the mirror check in figure 7.1. The tack-weld has caused pores and discolouration of the finished weld.

## DAMSTAHL - MIGATRONIC

The use of stainless steel is rapidly growing – it is one of the most important metals of the future. This imposes high demands on professional welders' mentality and practical knowledge of high-quality welding – and not least on builders' knowledge of product uses. In addition, all parties involved must keep updated on standards in force.

Damstahl and Migatronik know the challenges involved in producing and supplying high-quality stainless materials and welding machines and meet the requirements that enable our customers to manufacture hygienic and durable solutions.

For further information, please contact Damstahl and Migatronik.



The height of laziness is doing things right the first time

Source: unknown

Neither Damstahl nor Migatronik are liable to any third party for any errors that may arise due to improper use of the materials or equipment mentioned in this booklet.

- A man who works with his hands is a Laborer
- A man who works with his hands and his brain is a Craftsman
- A man who works with his hands and his brain and his heart is an Artist

kilde : Louis Nizer



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