

Manufacturing of an MI heating circuit

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Manufacturing of an MI heating circuit

This manual describes the procedure of manufacturing an MI heating circuit. If the heating circuit consists of more than one part, the procedure has to be repeated for each part (single loop).

Required materials and tools

Materials	2 cold leads, 2 connection sleeves, mineral insulated heating cable, wax, silver solder, soldering flux and quartz sand.
Tools	folding rule, diagonal cutters pliers, welding torch (propane), pipe cutter, pipe wrench, megger (1000 VDC), knife, pointed file, permanent marker, wet cloth and abrasive paper.

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Step 1: Cut double cold lead

Cut double cold lead in two half's each 1,2 m (figure 1). Use diagonal cutting pliers.



Figure 1
Cut double cold lead

Step 2: Waxing cable ends (heating cable and cold lead)

The insulating material is very hygroscopic (attracts water), therefore one of the cold leads must be sealed up. Remove some of the insulating material. Heat up 10 cm of the cold lead, move welding torch towards open end (figure 2). The hot cable will melt the wax - wax flows into the opening. Also insulating material soaks wax (figure 3).

When second cold lead will be manufactured (17th step) the sealed part has to be cut of completely, otherwise poor insulation resistance will be caused.



Figure 2

Cable end waxing 1



Figure 3

Cable end waxing 2

Step 3: Cut back and remove outer sheet

Cut back insulation of both heating cable and cold lead. Conductor length 5 mm. Cut outer sheet, use pipe cutter (figure 4).



Figure 4

Cut back insulation

Press gently cut cable to lose insulating material and pull off. Use pipe wrench (figure 5).



Figure 5

Remove insulation

Step 4: Preparation for welding

Select right sleeve in accordance to the heating cable type. Move connection sleeve on to heating cable (figure 6).



Figure 6

Preparation for welding

Adjust heating cable and cold lead for welding (figure 7). Distance between conductors will be 0,5 mm.



Figure 7

Cable adjusting

Measure insulation resistance (figure 8) with a 1000 VDC megger. A minimum of 100 MOhm should be reached.

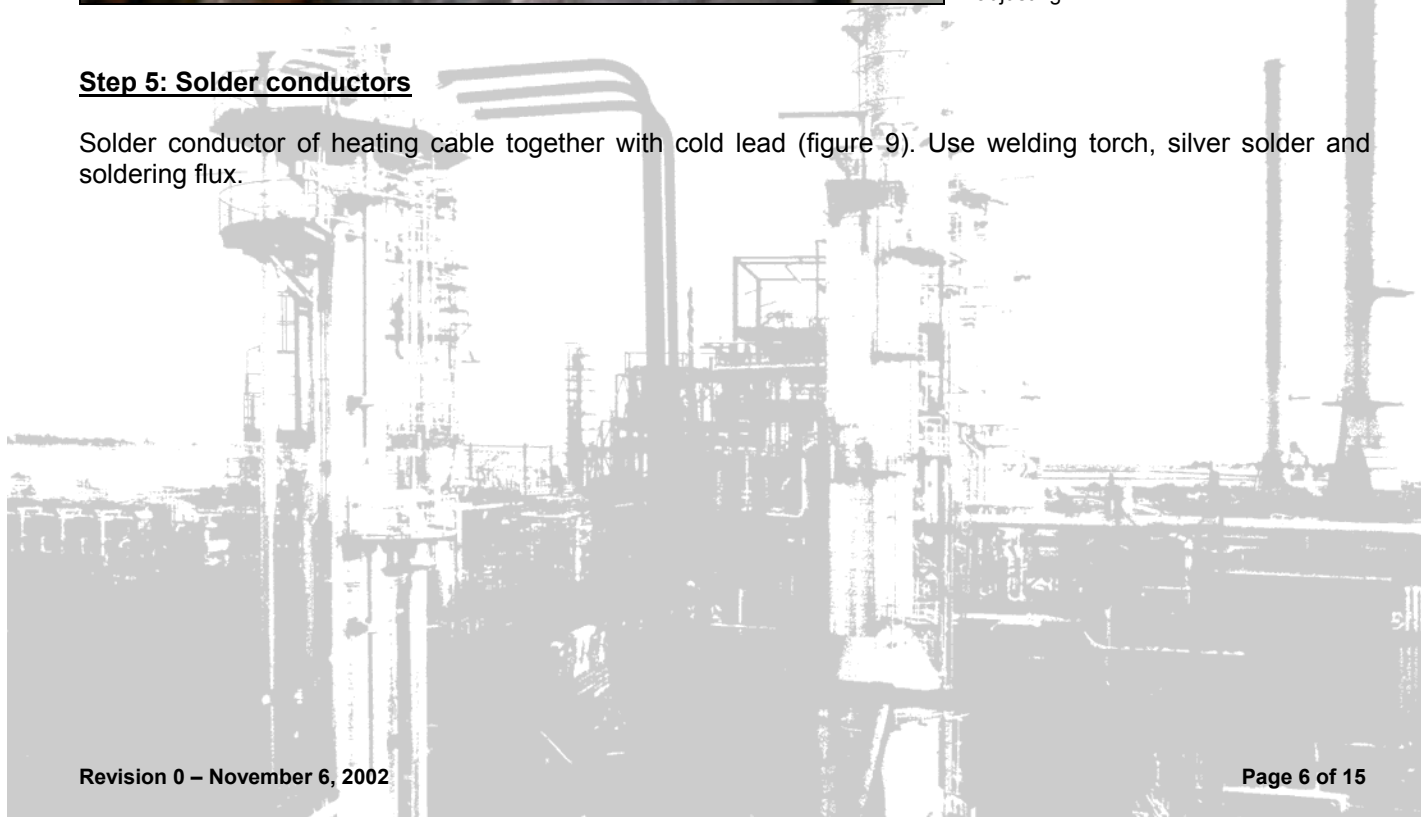


Figure 8

Measure insulation resistance after adjusting

Step 5: Solder conductors

Solder conductor of heating cable together with cold lead (figure 9). Use welding torch, silver solder and soldering flux.



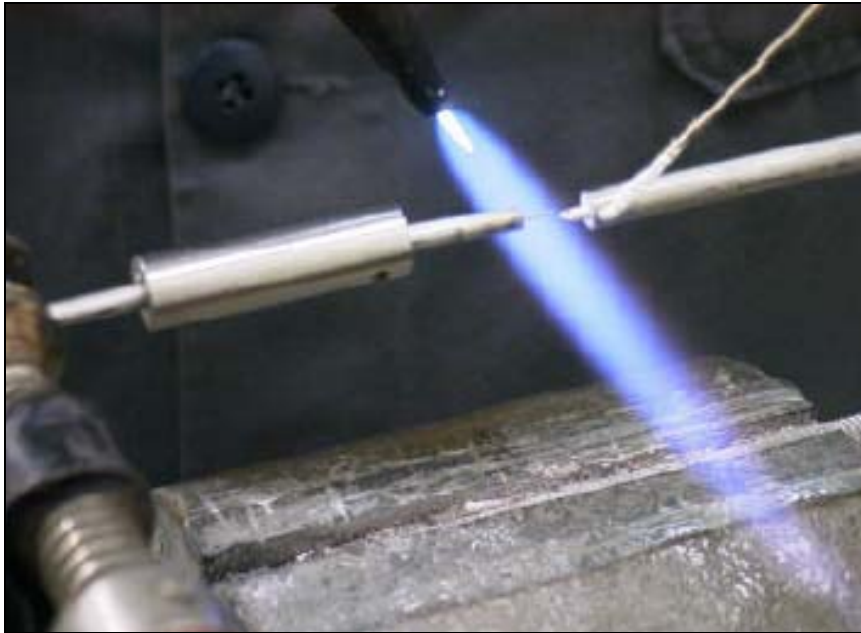


Figure 9

Solder conductors

Step 6: Clean soldered connection

After hard soldering clean – remove soldering flux (figure 10), use knife (or pointed file) Also remove soldering flux from magnesium insulation (figure 11), use pointed file. Be carefull not to damage the soldered connection!



Figure 10

Clean soldered connection 1



Figure 11

Clean soldered connection 2

Step 7: Measure insulation resistance

Measure insulation resistance (figure 12) with a 1000 VDC megger. A minimum of 100 MOhm should be reached.



Figure 12

Measure insulation resistance after welding

Step 8: Marking of cold lead

For the right position of the connection sleeve, the cold lead has to be marked (figure 13). Mark cold lead 15 mm from end of insulation. Use ruler and "Permanent Marker".



Figure 13

Mark cold lead

Step 9: Filling connection sleeve

Move connection sleeve towards cold lead. Make sure the opening lets the quartz sand through to the empty room inside (figure 14). Fill the connection sleeve with quartz sand. Make sure the empty room is sufficiently filled.



Figure 14

Fill connection sleeve

Step 10: Positioning of connection sleeve

Move connection sleeve onto cold lead (figure 15). The connection sleeve must be positioned at the mark. The connection sleeve has to fit tight.



Figure 15

Position of connection sleeve

Step 11: Measure insulation resistance

Measure insulation resistance (figure 16) with a 1000 VDC megger. An minimum of 100 MOhm should be reached.



Figure 16

Measure insulation resistance after positioning

Step 12: Soldering of connection sleeve

Solder both sides of connection sleeve heating cable (figure 17) and cold lead (figure 18).



Figure 17

Solder heating cable

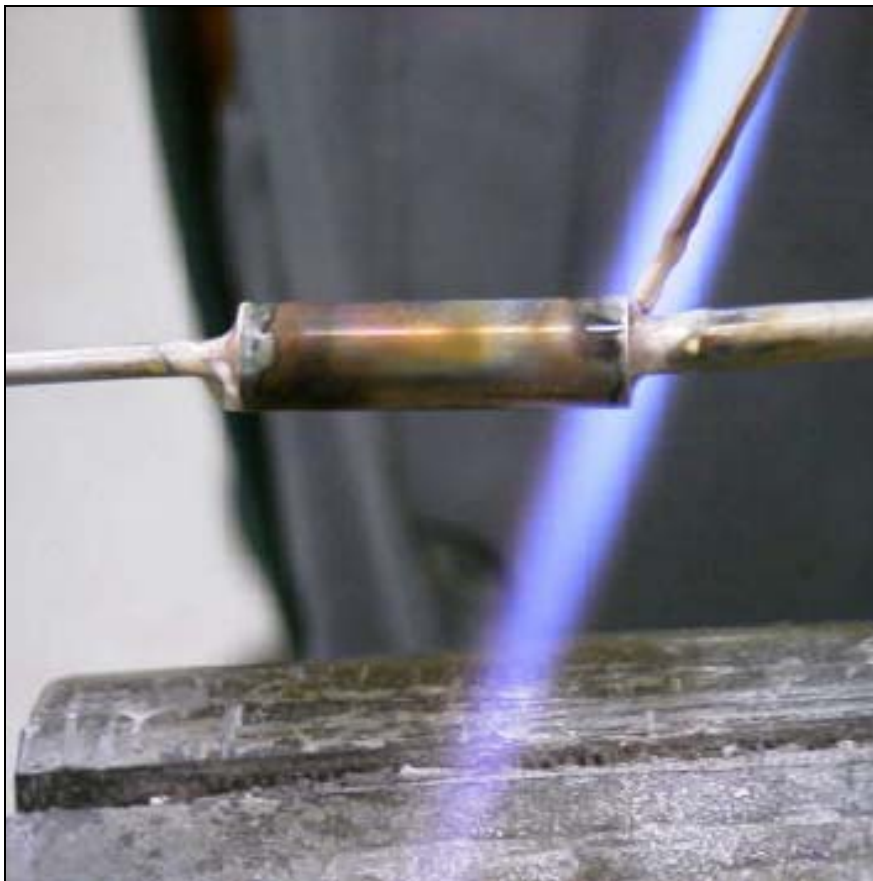


Figure 18

Solder cold lead

Step 13: Shut filling hole

Shut filling hole of connection sleeve by soldering.



Figure 19

Shut filling hole

Step 14: Wash connection sleeve and check if connection sleeve is well sealed

Right after step 13 (no time to spare) the connection sleeve has to be washed. Use well wet cloth (figure 20).



Figure 20

Wash connection sleeve

Measure insulation resistance (figure 21) with a 1000 VDC megger. An minimum of 100 MOhm should be reached. If connection sleeve is properly soldered the above mentioned value should be reached.



Figure 21

Measure insulation resistance after washing

Step 15: Check shut connection sleeve

File soldered connection plane (figure 22). Check edge of filling hole. Gabs or holes must not be seen! An example for a faulty soldered connection is shown in (figure 23). A quality soldered connection is shown in figure 24.



Figure 22

File connection sleeve



Figure 23

Faulty connection sleeve



Figure 24

Quality connection sleeve

Step 16: Finish connection sleeve

Finish connection sleeve use abrasive paper. Be careful cable breaks easily! Measure insulation resistance (figure 25) with a 1000 VDC megger. A minimum of 100 MOhm should be reached. If connection sleeve is damaged the insulation resistance will differ from the previous value.



Figure 25

Finish connection sleeve

Step 17: Second cold lead

When first cold lead is finished the same procedure has to be repeated for the second. Start at 2nd step last paragraph!

Step 18: Final inspection

Finally measure loop resistance (figure 26). The value “R” should be in accordance with cable length “l” and cable resistance “r” (per unit).

$$R[\Omega] = r \left[\frac{\Omega}{m} \right] \cdot l[m]$$



Figure 26

Measure cable resistance