Technical Paper

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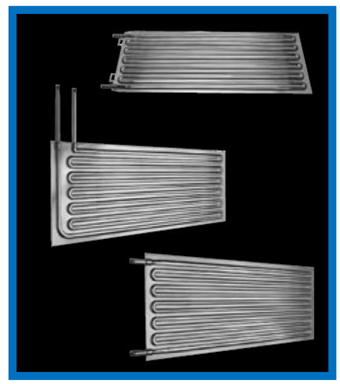
Advantages of DESCO-COIL™ vs. PLATE-COIL
Prime Surface Heat Exchangers

Background:

There are two (2) basic types of prime surface heat exchangers in the market place based on forming techniques. They are as follows:

- Die formed panel coils such as Plate-Coil and dimple type embossing which are primarily welded together using one or more of these welding techniques:
    - Electric Resistance Welding [ERW]
    - Resistance Spot Welding (RSW)
    - MIG welding



Typical Plate-Coil Type Panel

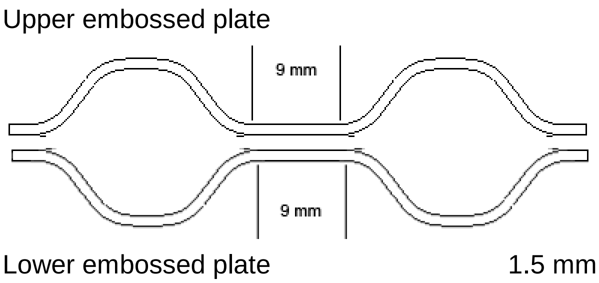
- Coils that are hydrostatically inflated to form a "pillow" like embossed product using one of two (2) primary welding techniques:
    - Electric Resistance Welding [ERW]
    - Laser Welding, i.e. **DESCO-COIL™**

DESCO-COIL™ Laser Welded Tank Clamp-on Coil

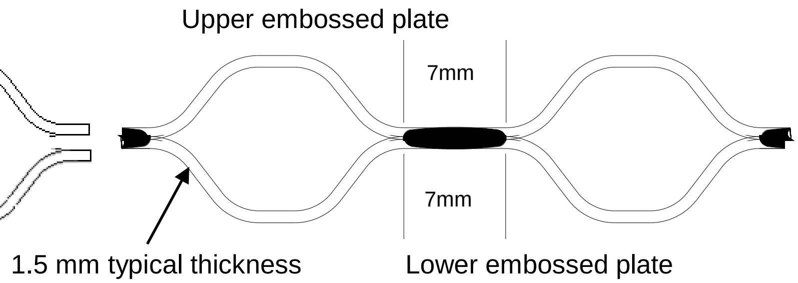
Manufacturing Techniques - Die Formed Embossed Panel Coils

Die formed embossed coils consists of two (2) flat sheets that are die-formed such that when the two (2) sheets are arranged together, they form a cross-section similar to that of a pipe. The sheets are then generally seam welded together to form the prime surface heat exchanger using ERW and RSW resistance welding or MIG welding.

Under ideal conditions the upper and lower embossed plates will lie exactly on top of each other allowing for a decent flat area, generally about 9mm (see Detail No. 1 below), that is conducive to a good seam weld. The width of the seam weld would be slightly less than the width of the flat area, or approximately 7mm (see Detail No.2 below).



Detail No. 1

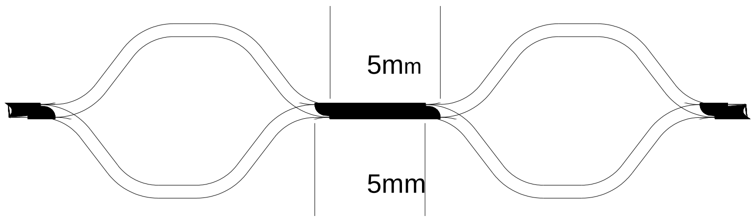


Detail No. 2

However, in the real world, conditions are not ideal and experience has shown that the processes indicated above seldom happen as designed. There are inherent problems that can arise for various reasons. The following is a review of these potential problems.

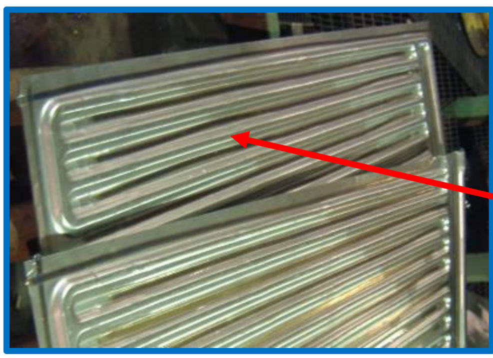
Potential Problem No.1: The embossed pattern in most cases is pressed in steps, such that there is a slight ‘banana’ or ‘bowing’ effect when the embossed plates are viewed from the top, as well as a ‘mismatch’ and distortion between each step pressing.

The net result of this is that the two (2) embossed plates would not fit as shown in Details No. 1 & 2 above, but more likely would fit as shown below.



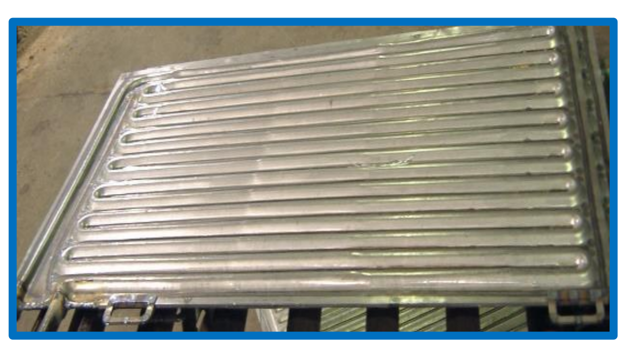
In this configuration, the actual size of the seam weld is significantly reduced, and could be as little as 5 mm, which would negatively affecting the pressure capabilities of the coil.

<u>Potential Problem No. 2:</u> Most manufacturers have a single headed seam-welder and therefore each pass is welded one at a time. This is a manual operation and the operator has to physically move the plate from one pass to the next, and also to take into account the 'bow' in the plate. Over the course of the day, fatigue comes into play and the ability of the operator to follow the correct path is diminished. When that occurs, the weld, instead of being directly in the center of the weld area, will stray to one side or the other, and will lessen the quality and size and therefore the strength of the weld.



<u>Potential Problem No. 3:</u> As the operators are welding the plates, the seam welding wheels will wear out, not necessarily evenly, and have to be re-machined to the original shape in order to maintain the weld quality. This once again is a manual operation and left to the judgement of the operator and therefore the quality and consistency of the weld is compromised.

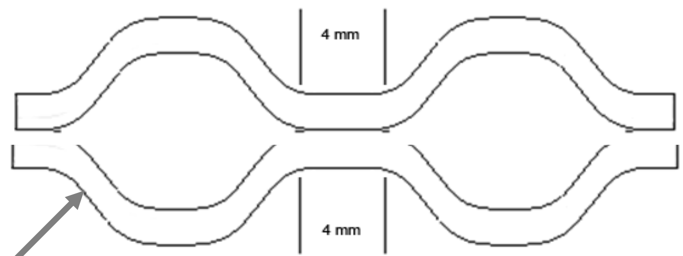
<u>Potential Problem No. 4:</u> In most cases, the plates are not clamped firmly during the welding operation and at the same time a considerable amount of heat is introduced in the plates. This results in the induced stresses during the forming operations to relieve themselves, and causes the plates to warp. The warped plates exert more, and uneven forces on the wheels increasing the difficulty



of controlling the weld location, resulting in inconsistent and substandard welds.
Example of warped plate-coil & inconsistent welds

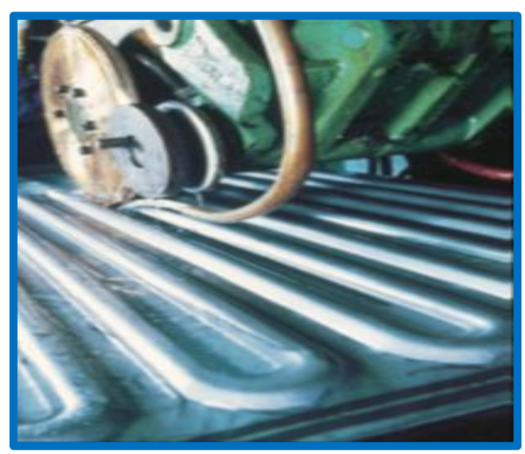
Potential Problem No. 5: Most manufacturers use the same die to form plates of varying thicknesses, ranging from 1.5 mm to 3.5 mm. The dies are designed to give good flats at one particular thickness. When the same dies are used for other than the design thickness, the normally flat area would end up with a radius that further reduces the amount of flat area to facilitate a good weld. This is especially so when pressing heavier thickness plates (3.5mm), since the pressing force is often not sufficient to flatten out these areas.

Shown to the right is typical of the reduction in the the flat area, from 9mm to 4mm, when pressing 3.5 mm plates instead of 1.5mm plates. With the narrower flats, the weld width is reduced to approximately 2.5 to 3.0 mm at best, which would diminish the weld strength.

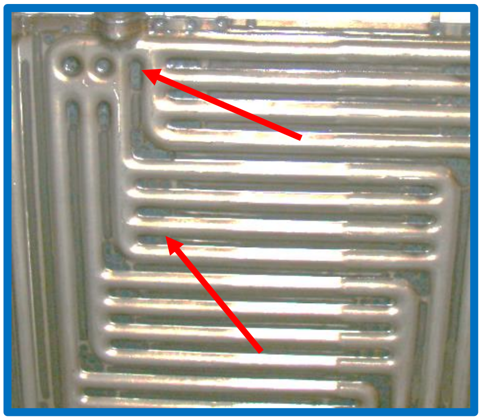


3.5 mm thick

Potential Problem No. 6: Since the coils are welded using a circular wheel, the diameter of the wheel will dictate how close the straight weld can be made, before it would run on and crush the header perpendicular to the straight weld. The operator has to stop the weld before it would run over the 'header' as can be seen in the photograph to the right.



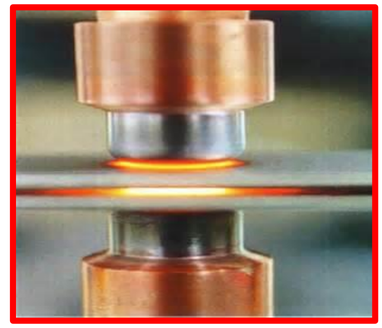
The distance to stop the weld from the 'header, or the perpendicular weld is also a manual operation, resulting in inconsistent unsupported spans. This could leave a rather large unsupported span between the straight weld and the vertical welds.



Typical spot welds at end of seam welds

To compensate for that, most manufacturers 'spot weld' from the end of the seam weld to as close as possible to the header. This is done in a separate resistance spot welding (RSW) machine.

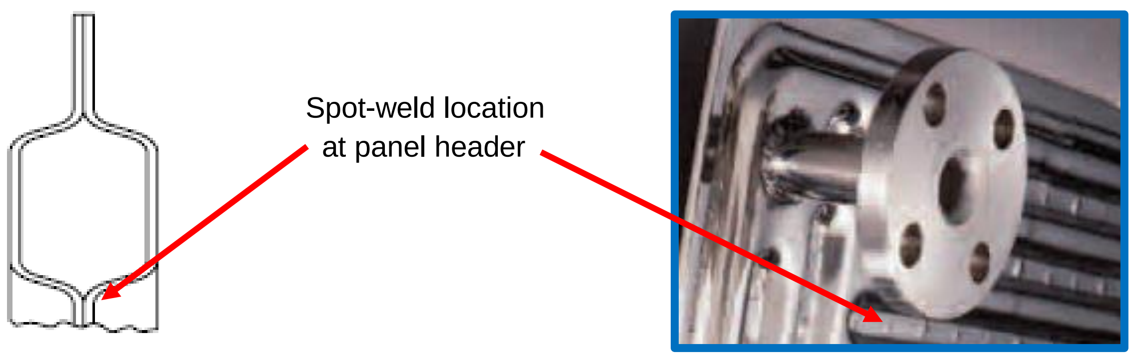
Typical resistance seam welding wheel



Resistance spot welding heads

These spot welds are the "weak links" in the entire plate for the following reasons:

1. The spot weld area is not as flat as it should be since the flat area of the embossing has to rise up to intersect the header area. This increases the possibility of a weak weld, especially the one closest to the header. See figures below:



2. The wear of electrodes is an inevitable result of the thermal and mechanical damage caused during spot welding. In order to correct for electrode wear, electrode 'dressing' is necessary. Dressing is conducted by machining the electrodes to maintain the original shape. However, this is generally left to the discretion of the operator, adding another variable to the operation.

3. If the end spot weld is NOT perfect, it would be the first one to shear, and this would increase the unsupported span to the adjacent weld and therefor the stress on it would increase, increasing the possibility of it shearing. This zipper effect would continue, until all the spot welds give way and the resultant material would 'balloon' out and eventually fail.

Example of actual "zippered" failure

4. The problem gets further magnified when using the heavier gauges, since as illustrated above, the flat areas become smaller as the plate thicknesses increases.

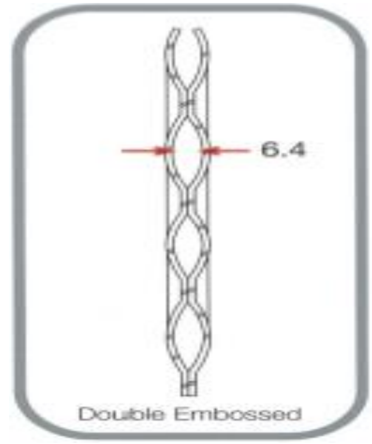
Manufacturing Techniques – Laser Welded DESCO-COIL™

How the manufacturing techniques described above for die does formed embossed panel coils compare with those of DESCO-COIL™ hydrostatically inflated embossed coils?

DESCO-COIL™ is produced when two (2) flat cold rolled sheets of material are cut to the desired sizes, and clamped in a sophisticated fixture to maintain the sheets in place. The plates are then seal-welded on the perimeter and laser spot welded intermittently or laser seam welded across the body of the plate. This is done using a state of the art automated computer controlled laser welding machine. Coils are then hydrostatically inflated to form a "pillow" like embossed product.

Typical laser welded and hydrostatically formed DESCO-COIL™

Laser seam welded DESCO-COIL with a “Multi-zone” pass configuration



The machine is pre-programmed for the number and locations of the welds depending on the design parameters. The process does not require any manual operation other than clamping and releasing the plates from the fixture. During the entire operation the plates are stationary while the weld head moves to predetermined locations and completes the weld.
Eliminating movement of relatively heavy plates (as is manually done in embossed plates) removes the human ‘fatigue factor’ from the equation. Since the plates are not ‘preformed’ there are no stresses to be relieved and therefore the plates remain in the flat condition throughout the operation and provides consistent excellent quality welds.

State-of-the-art automated laser welding of DESCO-COIL^{TM} panels offers the following welding advantages when compared to Electric Resistance Welding [ERW], Resistance Spot Welding (RSW) or MIG welding:

- Narrow heat affected zone
- Low total thermal input
- Ability to Weld dissimilar metals
- No filler metals needed
- No secondary finishing needed
- Extremely accurate
- Produces deep and narrow welds

- Low distortion in welds
- High quality welds
- No contact with the material being welded
- Welds performed under an inert gas blanket (shielding gas), preventing oxidation of welds

Conclusion:

It is easily observed that all the potential problems and pitfalls that are present in the manufacturing of the die formed embossed panel coils are eliminated in the manufacturing of laser welded DESCO-COIL^{TM}, and therefore offers a superior quality product.

The ability to produce this high quality product offers customer's savings in time and money. Our CNC operated laser welding machines achieve optimal accuracy that allow flexibility that is unmatched by any other heat transfer product welding process.