



# Metalworking/Automotive

## Metalworking

Metalworking is a vast industry covering a broad spectrum of process stages. These range from actually producing a metal to finishing an end-product, such as a door handle on a car or a cold drink can.

Correct temperature control of service fluids within the metalworking industry can have a huge impact on plant profitability. Service fluids are used in the process of shaping the metal as well as for cooling and lubricating machinery used for shaping metal materials.

The road from extracting metal mineral from rock to a finished product is very long and more or less every step needs some sort of cooling and heating.

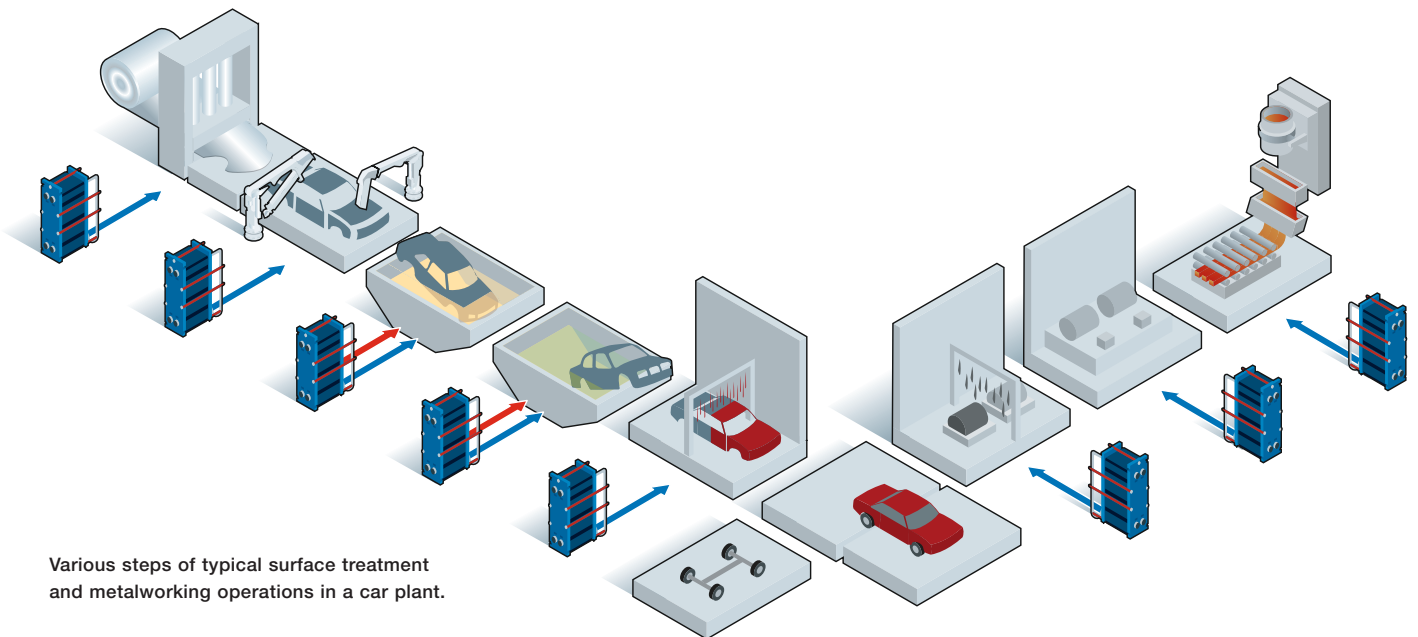
When it comes to service fluids for metalworking, Alfa Laval has extensive process know-how that will save customers money.

## Automotive

Metalworking is closely connected to the Automotive and Vehicle industry and a large volume of the sheet metal and cast and finished components

produced are supplied to this industry. Not only is the automotive industry a large consumer of metal components, it is also an industry with very high quality demands. This is an advantage for Alfa Laval, a company which fulfills and leads all qualitative developments within plate heat exchanger manufacturing.

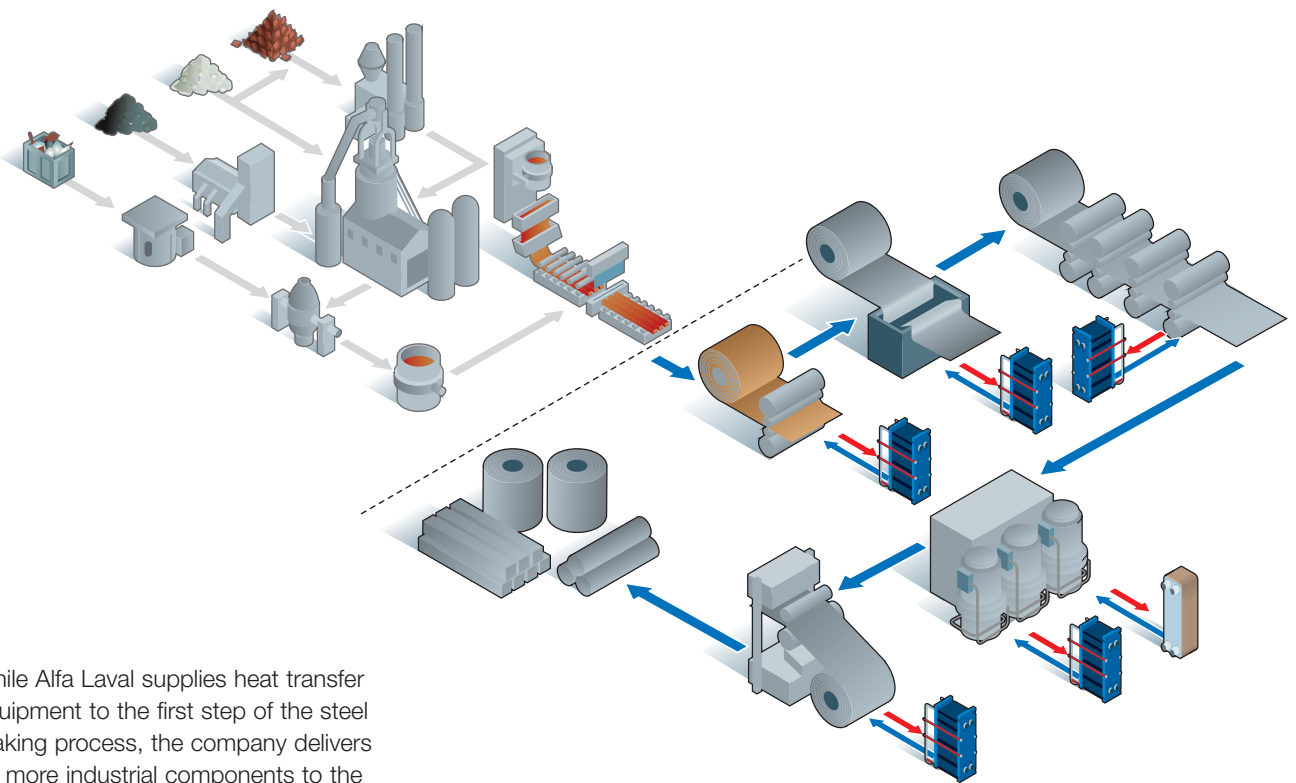
Alfa Laval also supplies temperature control solutions to many processes around the vehicle industry such as dynamometers, wind tunnels and engine testing.



Various steps of typical surface treatment and metalworking operations in a car plant.



## From mineral to material



While Alfa Laval supplies heat transfer equipment to the first step of the steel making process, the company delivers far more industrial components to the second step where molten steel becomes a component. This is also the part where system builders around the world supply equipment for metal shaping. The majority of these systems and machines incorporate coolers and heaters of various kinds.

### Caster

In the caster molten steel is turned into solid slabs of steel and the most common casting process is continuous casting. From the ladle the molten steel flows into the tundish of a caster from where it then flows into the caster's water-cooled mould. As the steel travels down the caster, it solidifies with the help of water sprays. The steel comes out of the caster at the end of

the process in red-hot solid slab form, and is then cut to the desired length.

### Hot strip rolling mill

Rolling is the main method used to shape steel into different products. The rolling process consists of passing the steel between two rolls revolving at the same speed but in opposite directions. The gap between the rolls is smaller than the steel being rolled, so that the steel is reduced in thickness and at the same time lengthened. Two rolls opposite to each other together are called a "stand". A rolling mill may consist of up to 10 or more stands.

Hot rolling is a hot working process. Here a cast slab is converted into

sheets (which are often coiled at the end of the process). First the slabs from the caster are reheated in the re-heat furnace. After this they are moved, one by one, on a conveyor to the hot rolling mill. Here the slabs are rolled as often as necessary to reach the desired measures. After rolling, the steel is normally pickled to remove oxides from the surface. At this point, some products, such as steel plates, may be ready for shipping, but most of the products have to be further treated by a cold working process. This is often called cold rolling, but for wire and tubes drawing is also usual.



### **Pickling line**

Pickling prepares the surface for further processes. Pickling removes oxides from the surface by immersion in an acid bath. After this the acid is rinsed off and the steel is dried. As a final stage, the surface is oiled to protect further oxidation.

### **Cold strip rolling mill**

Cold rolling is a cold rolling process in which the steel sheets are made thinner and formed into the desired shape. The advantages of cold rolling compared to hot rolling are for example

better thickness tolerances and less oxidation. As a final stage and between cold rolling processes the steel may be annealed.

### **Annealing**

After the cold rolling process the steel is too hard and inflexible. Annealing makes the steel more suitable for forming and bending. Annealing is a heat or thermal treatment process. The steel is heated to a designated temperature for a sufficient amount of time and then cooled.

### **Products**

The final product from this industry can be a sheet, a bar (round or rectangular), a coil or a wire which will then be further worked on in various industries. The majority of the products will also be coated in one way or another. This is described further below.





## Premium metal components

Products from the metal making process are sold onward to companies which will add value to the product and sell it as a finished product. These companies normally perform one or more of the following operations:

**Alfa Laval supplies temperature control solutions for most of these processes, e.g.:**

- Anodizing
- Chromium plating
- Coolants
- Copper plating
- Cutting oil
- Degreasing
- Honing oil
- Hydraulic oil
- Lapping oil
- Lubrication oil
- Nickel plating
- Paint
- Passivating
- Phosphating
- Pickling
- Process water
- Quench oil
- Rolling oil
- Sintering oil
- Test bed oil
- Wash liquid
- Zinc plating

### Machining

The typical processes are cutting, turning, forming, pressing and drawing of the product. These operations require a lot of cooling and lubrication. The service fluids can be e.g., water-based coolants, neat oils or pressing emulsion and the functions of the fluids include:

- Cooling
  - cool the tool (wear)
  - cool the workpiece (measures)
  - cool the chips (breaking)
- Lubricating
  - between the tool and material
- Transportation of swarfs
  - prevent tearing of machine & tools
- Corrosion prevention

### Heat treatment

In the metallurgical, metal working and mechanical industry, a wide array of heat treatments is performed on

various metals. In many metal working processes the workpieces are heat treated to relieve stresses or to provide certain other desired surface properties. The process is normally divided into:

- Softening, which is normally achieved by heating and slow cooling (annealing, described earlier)
- Hardening, which is normally achieved by heating and rapid cooling (quenching, described below)

The service fluids identified with these two processes are normally oil and process water.

### Induction heating

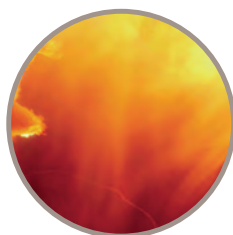
Heating a metal in order to create the correct properties can be done by electromagnetic induction. This requires cooling of the electric rectifier and of the induction coil.

## Metalworking applications



### Machining

Cutting  
Forming  
Pressing  
Coolants Oil



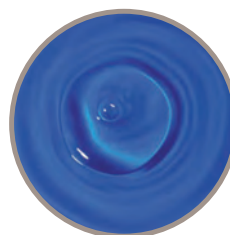
### Heat treatment

Quenching  
Annealing  
Quench Oil  
Process water



### Degreasing

Washing  
Degreasing  
Water  
Solvent



### Surface treatment

Phosphating  
Plating  
Anodizing  
Painting  
Acids  
Paint



### Automotive

Test Bed  
Dynameters  
Wind tunnels  
Oil  
Water  
Air



### Quenching

During forging, the metal part is heated to 800 - 900°C in a furnace. To cool the metal, avoiding oxidation, the work-piece is quenched in a tank filled with quench oil or water emulsion. Due to environmental controls and fire regulations, there is a trend in many countries to use synthetic oils instead of the traditional mineral oils.

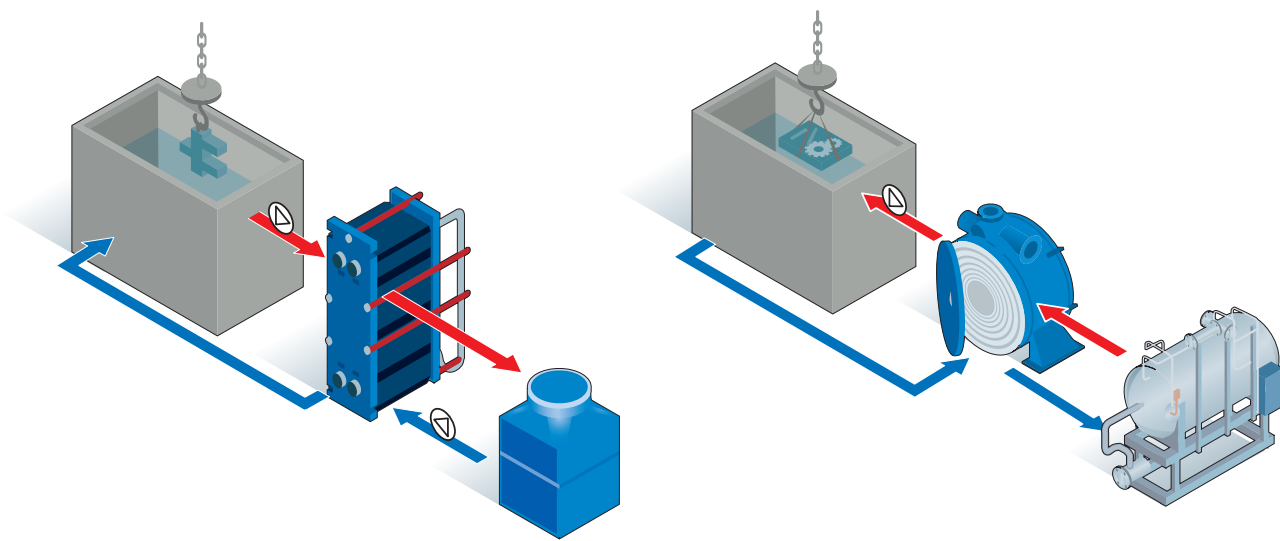
The characteristics of the quenching fluid and its desired temperature vary according to the material and the type of workpieces that need to be quenched. Usually, baths are kept at a temperature in the range of 40 - 70°C,

in the manufacturing process, batch or continuous. A heat exchanger is needed to control the temperature of the quenching bath.

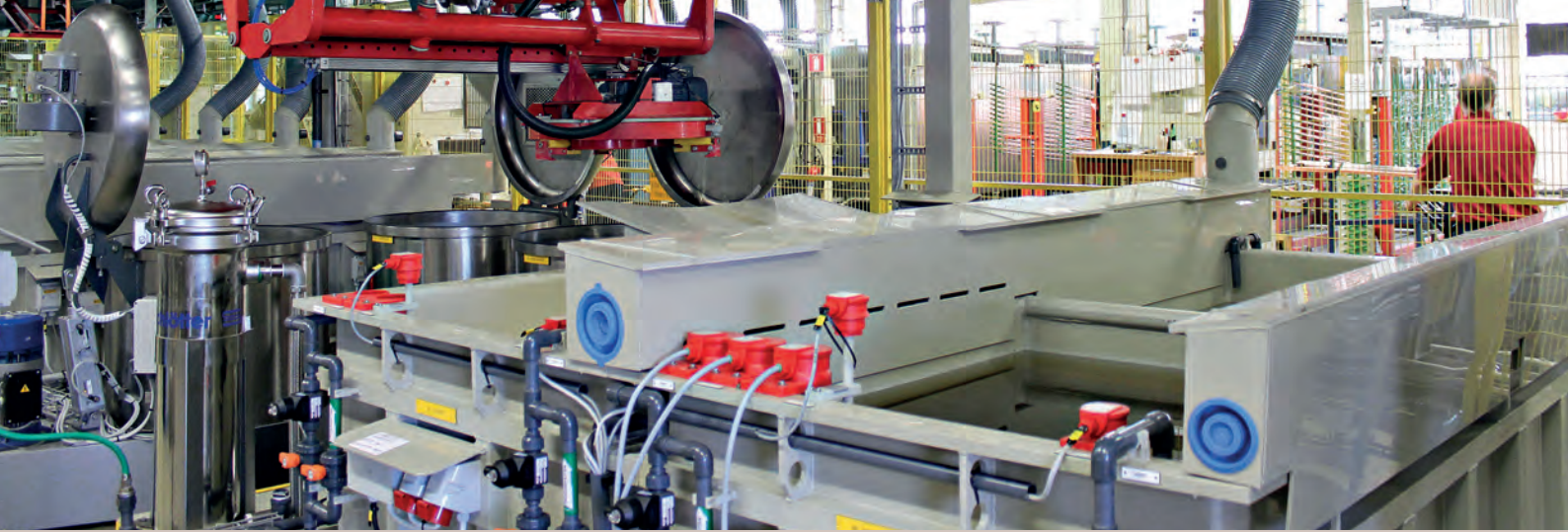
Special attention has to be paid to the clogging problem. Particularly when quenching steel pieces, large numbers of steel flakes or particles form a suspension together with the oil. In this case a PHE with a wide channel or a spiral heat exchanger may be chosen. Spiral heat exchangers not only overcome clogging but are also better protected against erosion. In some installations, water mixing with quench

oil can cause steam explosions. Therefore the customer wants to be absolutely sure that no leakage between the two fluids occurs. In these cases a double-wall PHE is often the preferred solution.

Alfa Laval can supply all these types of heat exchangers and several others, depending on the need within the application.



Cooling of quench oil utilizing a PHE for cleaner applications and a spiral heat exchanger for applications which carry a lot of dirt and particles.



### Surface treatment

Surface treatment is a process where the surface of the metal parts is cleaned in order to add paint or (thin) metal layers for protection against wear and corrosion as well as for decorative purposes. Almost all operations involve fluids that need heating or cooling.

Due to the nature of metals, different metals are treated and coated differently, although all metals are first washed and degreased. The diagram below provides a guideline for the various steps following degreasing:

### Washing/degreasing

The performance of the washing varies depending on machining conditions as well as the type of pollution, material, demands on degree of purity, etc. In general one or more wash steps are used followed by rinsing in one or more steps. If the product is highly polluted

there can be a pre-rinsing step before the washing process.

The type of wash liquids used depends on the type of pollution and the material of the workpiece. In general, water-based alkaline wash liquids are suitable for removing particles, while solvent-based wash liquids are suitable for removing fat and oil.

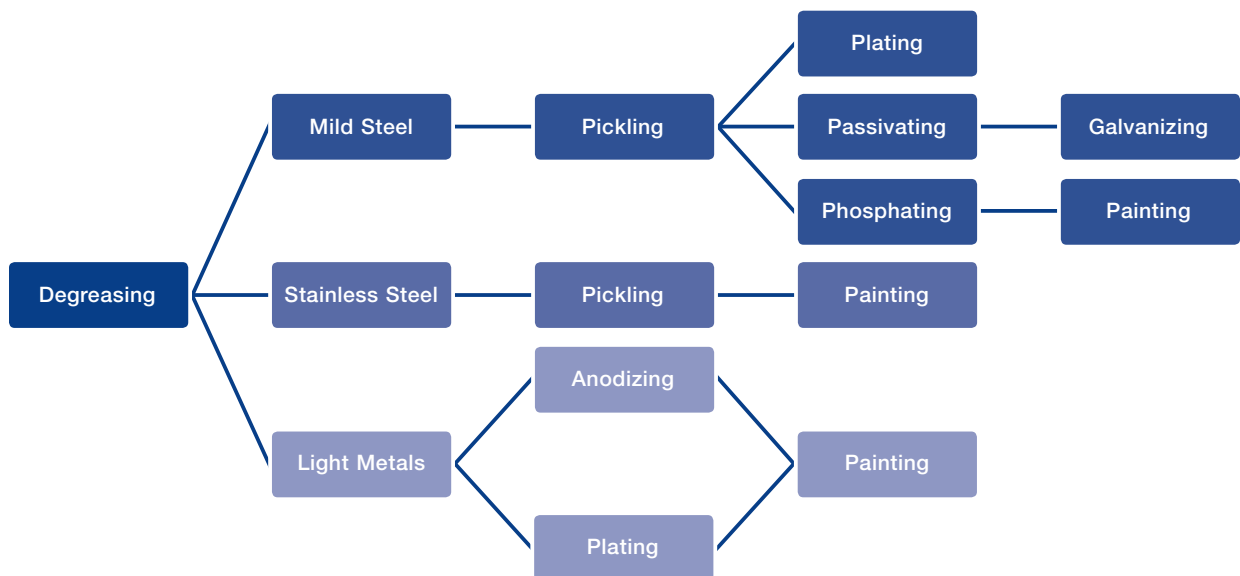
- Water-based wash liquids (alkaline)
  - pH from neutral to 14
  - Effective particle removal
  - Environmentally friendly
- Solvent-based wash liquids (acid)
  - pH 1 - 5.5
  - Effective fat and oil removal
  - Poor particle removal
  - Affects the environment
  - Suitable for aluminium and stainless steel

### Pickling

Pickling is a process where oxides are removed from the surface of objects. This operation produces a smoother surface which will improve the results of phosphating and painting.

Many hot working processes and other processes that occur at high temperatures leave a discolouring oxide layer or scale on the surface. In order to remove the scale the workpiece is dipped into a tank of pickling liquid.

The most commonly used acid is hydrochloric acid, however sulfuric acid is also used. Hydrochloric acid is more expensive than sulfuric acid, but it pickles much faster while minimizing base metal loss. The speed is a requirement for integration in automatic steel mills that run production at high speed.





Carbon steels, with an alloy content less than or equal to 6%, are often pickled in hydrochloric or sulfuric acid. Steels with an alloy content greater than 6% must be pickled in two steps and other acids are used, such as phosphoric, nitric and hydrofluoric acid. Rust and acid resistant chromium-nickel steels are pickled in a bath of hydrochloric and nitric acid. Most copper alloys are pickled in dilute sulfuric acid, but brass is pickled in concentrated sulfuric and nitric acid mixed with sodium chloride and soot.

The duty conditions for this application can vary greatly. The heat exchanger duty is temperature control by heating. The traditional system design is to heat the bath with submerged heating coils. The objects can be lowered into the tank or sprayed with the liquid.

### Plating

Plating creates a metal layer on the surface of a component, often by using an electrolytic process. The purpose is

to achieve hard and wear resistant surfaces (hard chromium plating) or to improve the finish on the object (decorative chromium, copper and nickel plating).

In the process the components to be plated are immersed in a solution called an electrolyte, containing one or more dissolved metals. A power supply supplies a current so that the dissolved metal ions in the electrolyte solution create a metallic layer on the components.

The plating metals can be combined in several layers, such as copper followed by nickel plating, or nickel followed by chrome plating.

### Passivating

Passivating is performed to prevent oxidation. A thin layer of chromic acid is applied to the surface. The objects can be lowered into the tank or sprayed with the liquid. The heat exchanger duty is temperature control

by heating. The traditional system design is to heat the bath with submerged heating coils.

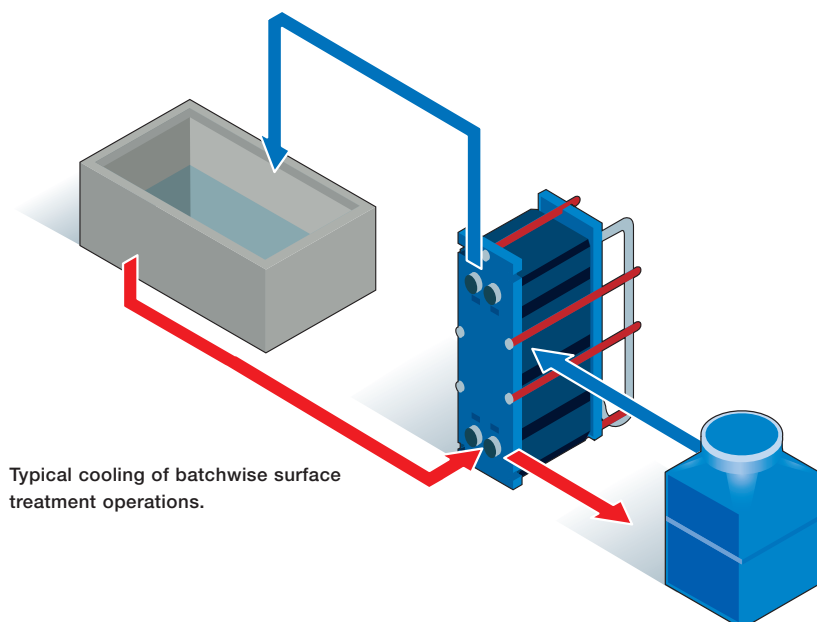
### Phosphating

Phosphating of metals is one of the most important surface treatment methods and a number of modern metal finishing procedures would not be possible without it. The main areas of application of phosphating are:

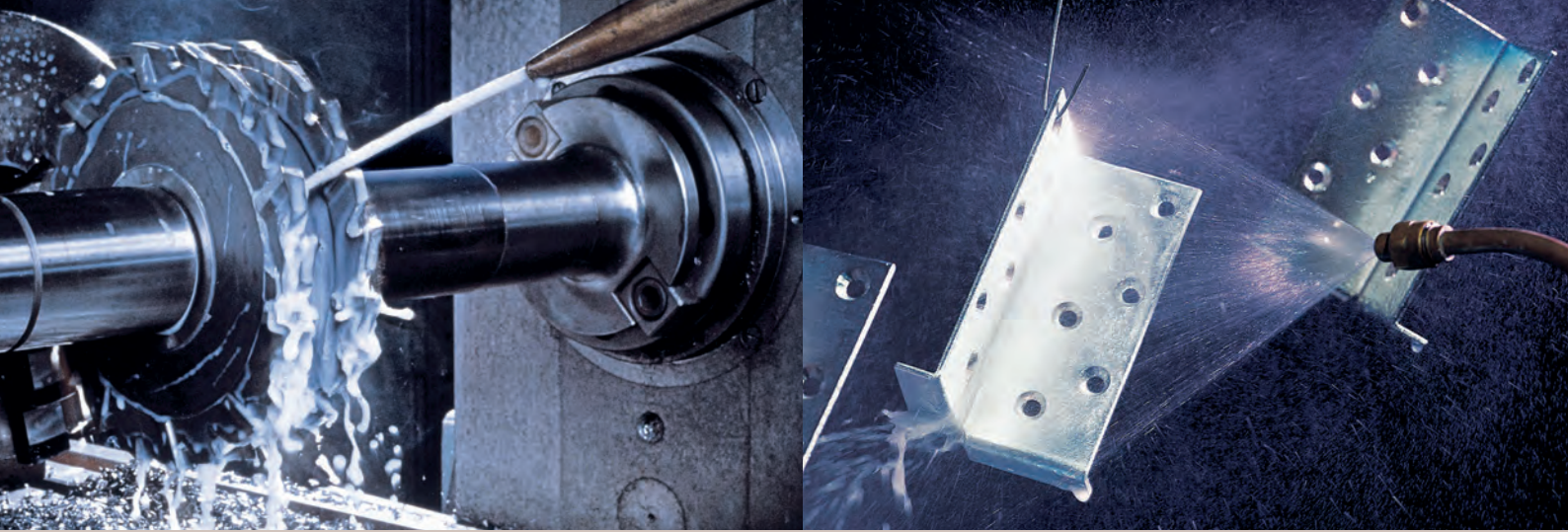
- Corrosion protection in conjunction with organic coatings, e.g., paints and polymer films
- Facilitation of cold-forming processes, e.g., wire drawing and tube drawing, deep drawing
- Corrosion protection in conjunction with oils and waxes
- Corrosion protection with no subsequent treatment.

Of the many phosphating systems which have been proposed, the following are of industrial importance: zinc phosphate, iron phosphate, manganese phosphate. Such phosphating systems are predominantly applied to iron and steel, as well as zinc surfaces, whereas other metals which can be phosphated, e.g., aluminium or magnesium, are less commonly processed by this method.

Phosphate coatings which adhere well to the base metal and which, so far as possible, cover it completely, can only be formed on clean surfaces which are free from rust, scale and other corrosion products. Oil and grease films likewise inhibit phosphate coating formation, except when they are so thin that they are removed by an initial etching stage.



Typical cooling of batchwise surface treatment operations.



The phosphate solution is an application with a high risk of scaling. When the phosphating process is not in operation, the solution remaining in the PHE gets cold and a salt of zinc- or iron-phosphate will precipitate onto the plate surface. The salt is very hard and difficult to remove, resulting in a frequent need to open and clean the PHE. The wall temperature should be kept as low as possible to avoid deposits growing too fast on the heat surface. In this aspect zinc-phosphate solutions are more sensitive than iron-phosphate. A way to prevent deposit growths is to use recirculation on the hot side, making it possible to reduce the temperature on the hot side. If the customer wants to use steam as the heating media, it is advisable to install an intermediate PHE for heating of

water by means of steam. The heated water is then sent into the second PHE to heat the phosphating bath

### Anodizing

Anodizing is an electrolytic process where objects are oxidated (covered by an oxide layer). Anodizing is used for light metals such as aluminium, magnesium, titanium and zinc to achieve higher corrosion and wear resistance or to obtain a decorative finish. The oxide layer provides an excellent basis for impregnation, colouring or painting.

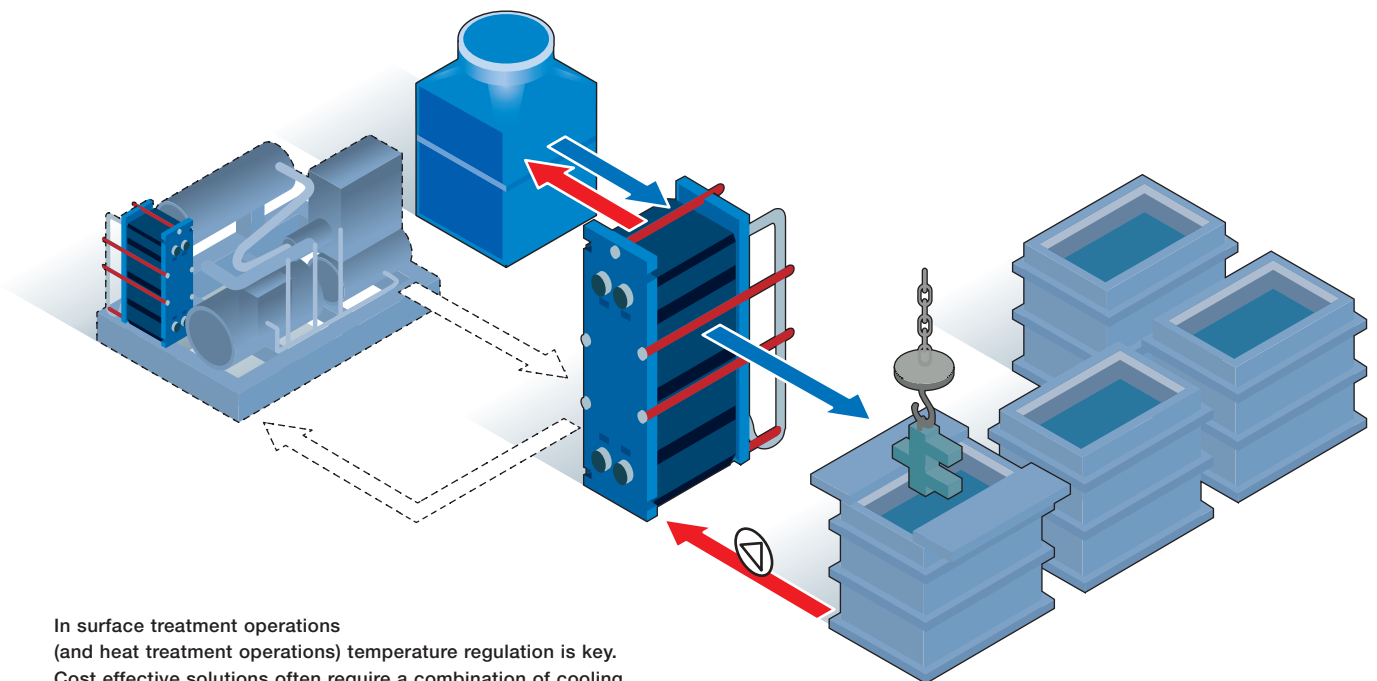
Aluminium anodizing is usually performed in an acid solution which slowly dissolves the aluminium oxide. Conditions such as electrolyte concentration, acidity, solution

temperature, and current must be controlled to allow the formation of a consistent oxide layer. Other types of anodizing processes are:

- Chromic acid anodizing
- Sulfuric acid anodizing
- Organic acid anodizing
- Phosphoric acid anodizing

### Galvanizing

Galvanization is the process of applying a protective zinc coating to steel or iron, in order to prevent corrosion. This can be achieved by hot-dip galvanization or by electro-galvanization (i.e., zinc plating). It is primarily the electrolytic process that is of interest for Alfa Laval, since it involves heating of the bath where components are treated.



In surface treatment operations (and heat treatment operations) temperature regulation is key. Cost effective solutions often require a combination of cooling and heating technologies (depending on the ambient temperature).





## Painting

The painting process usually consists of three main steps:

- Adding a primer to prevent rust
- Adding a surfacer to ensure that the paint adheres and covers well
- Coating with a colour

Temperature control of the paint is of the utmost importance in order to provide the exact properties of the various coatings. Alfa Laval can supply many different heat exchangers matching different demands in this process. The unique Alfa Laval AlfaNova enables the paint companies

to handle the paint without any risk of contaminating copper ions.

## Heat exchangers in surface treatment

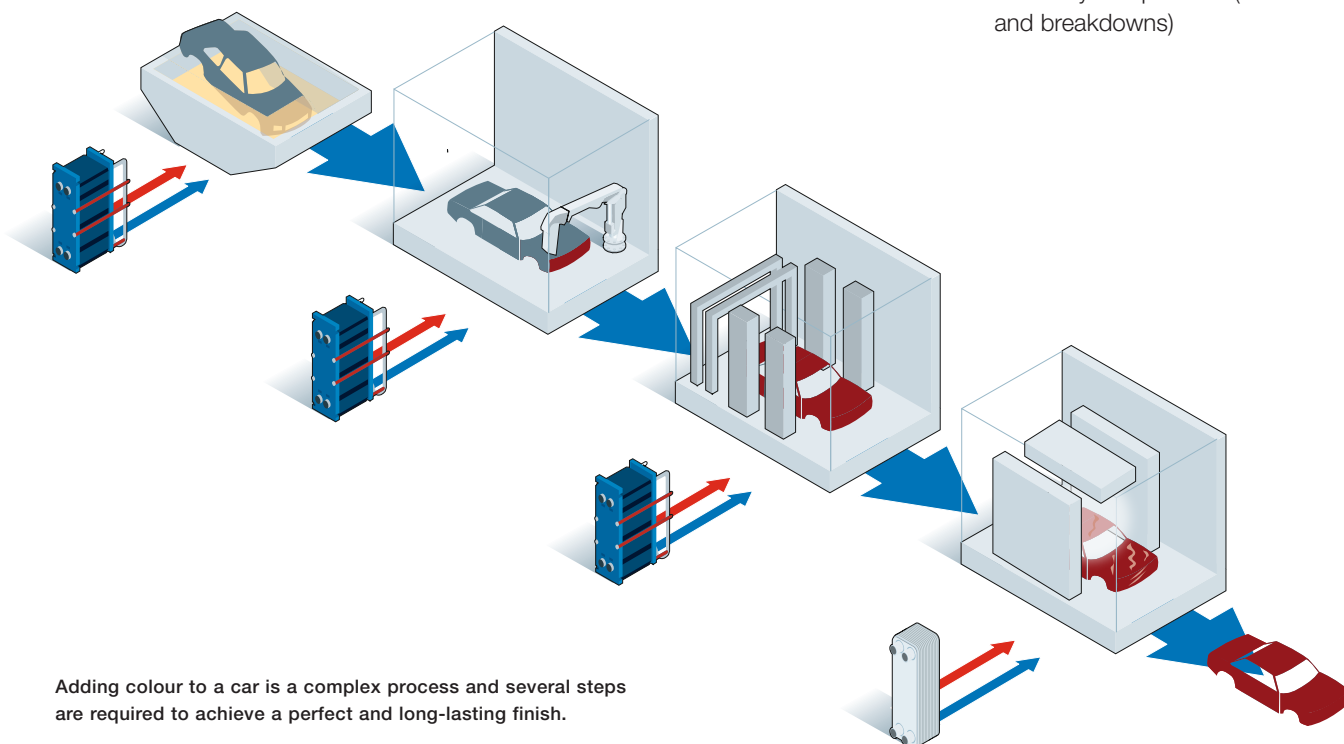
Surface treatment normally involves heating different process fluids in a number of tanks. This means that multiple heat exchangers are needed and in many cases utility coolers are also needed. A pump normally circulates the process fluid through the heat exchanger, which uses a cooling media, typically water. The cooling media can then, in turn, be cooled by a chiller or a radiator or both.

## Advantages of a Plate Heat Exchanger

The sizing of a heat exchanger is often based on heating a fluid in the tank, which is called a batch calculation. The most common heat exchanger in surface treatment is a simple coil. However, it is often an advantage to replace submerged coils with external heat exchangers.

The advantages include:

- Less tank and fluid volume required
- No risk of damaging the coils when objects move up and down in the tank
- Recirculation of the fluid gives stirring which decreases or eliminates the need for agitators
- Easier maintenance
- Stand-by unit possible (for service and breakdowns)



Adding colour to a car is a complex process and several steps are required to achieve a perfect and long-lasting finish.



### **Automotive applications**

Modern vehicles have to meet increasingly demanding requirements relating to economical fuel consumption, low emissions and an enjoyable driving experience. In order to develop reliable solutions all the major vehicle manufacturers and their sub-suppliers have rigorous testing facilities where they simulate operation of each component. Most of these test benches and test rooms need temperature and climate control. Alfa Laval is a well-known supplier within this field supplying state-of-the-art technology with a small footprint and efficient heat transfer area.

### **Choose the right technology and help save the planet**

Whatever the metalworking process, whatever the service fluid, water-based

or oil-based, accurate temperature control and efficient cleaning are essential to ensure end-product quality. Not every metalworking operation may include every process mentioned above but all processes involve water-based or oil-based service fluids – these fluids are in short supply and are even scarce in many places on the planet.

Energy efficient products and heat recovery are other factors that strongly influence total cost of ownership.

Combining these two parameters makes temperature control vital for a sustainable future.