

Line Bending

Introduction

Thermoplastic sheet materials such as acrylic can be softened by heat. When a thermoplastic sheet has been softened, it can be bent, twisted, rolled and stretched. After the thermoplastic has cooled down, it becomes rigid and remains in its new deformed shape. This makes thermoplastic sheet materials suitable for:

- line bending
- compression moulding using a plug and yoke
- vacuum forming

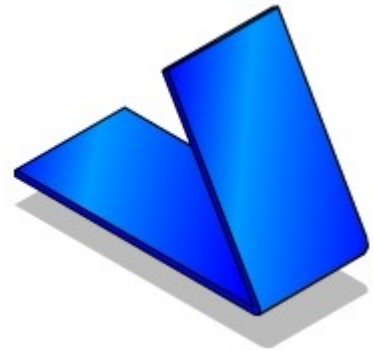
Please refer to [CLEAPSS, Model Risk Assessments for Design and Technology in Secondary Schools and Colleges, Part 1.061 COSHH Regulations.](#)

Line Bending

Line bending is a process used to bend thermoplastics in a straight line.

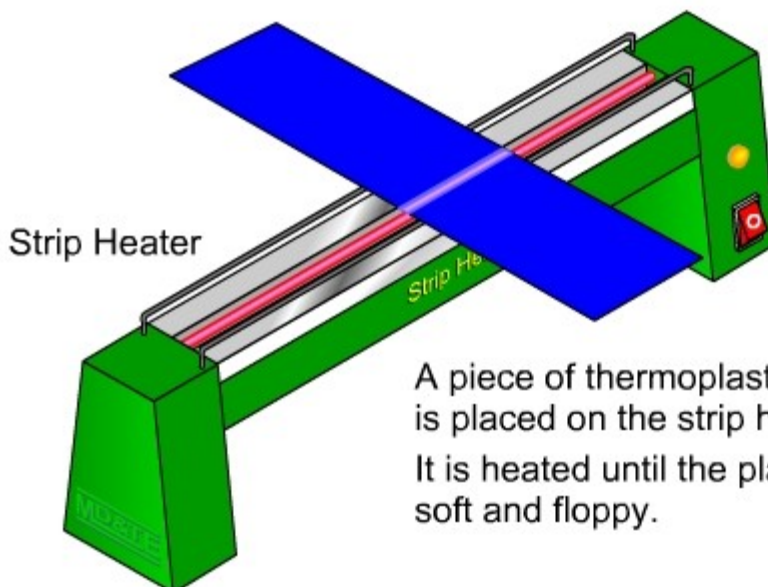
The line bending process involves heating a thermoplastic sheet over a strip heater until it becomes soft and then bending it to any desired angle.

The plastic sheet is then held still until it cools and stays in the bent shape.



Line Bending

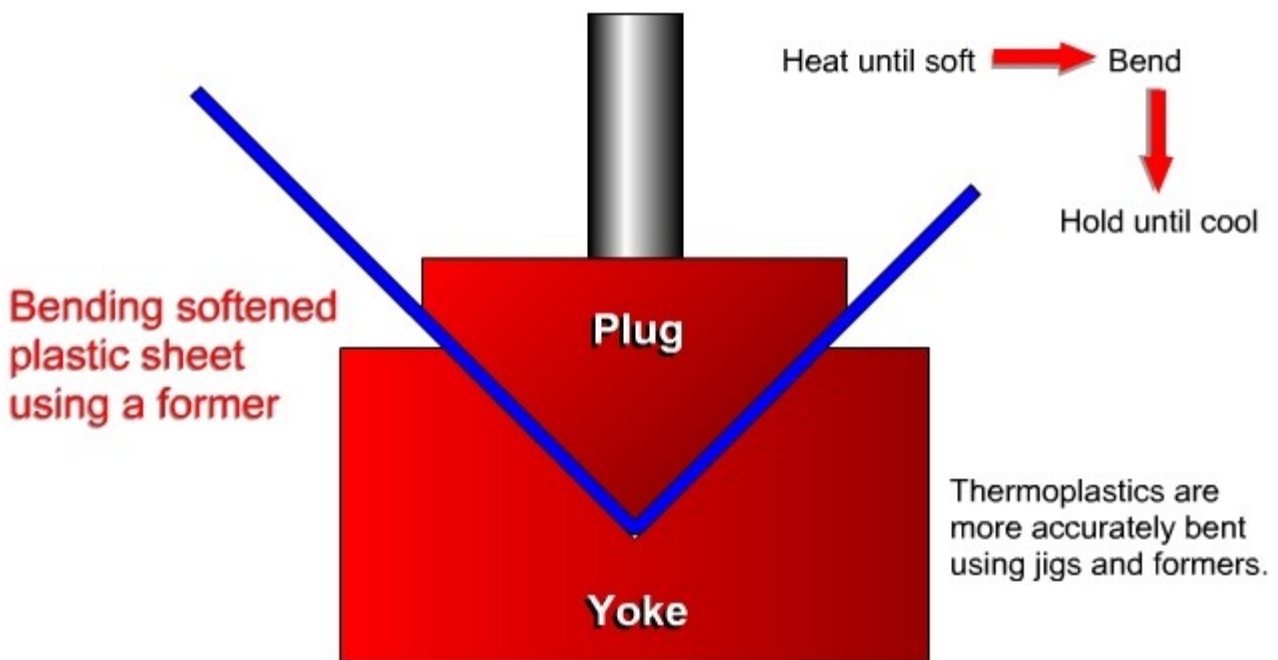
Heat until soft → Bend → Hold until cool



A piece of thermoplastic sheet material is placed on the strip heater.

It is heated until the plastic becomes soft and floppy.

Line Bending



The table of plastic processing temperatures below shows the temperatures at which thermoplastic sheets may be bent using the line bending process. The figures in the "Orientation" column give the optimal temperature at which the polymers may be bent.

Plastic Processing Temperatures In Degrees Celsius				
Polymer	Abbr.	Lower processing	Orientation	Upper Temperature
Acrylonitrile-butadiene-styrene	ABS	127	138	204
Polystyrene	PS	127	135	182
Polyethylene, high density	HDPE	127	132	221
Polypropylene	PP	132	138	193
Polymethyl methacrylate (Acrylic)	PMMA	149	163	218
Polycarbonate	PC	168	177	204

Plastic processing temperatures source: MAAC Machinery Corporation, www.maacmachinery.com

Line Benders / Strip Heaters

Introduction

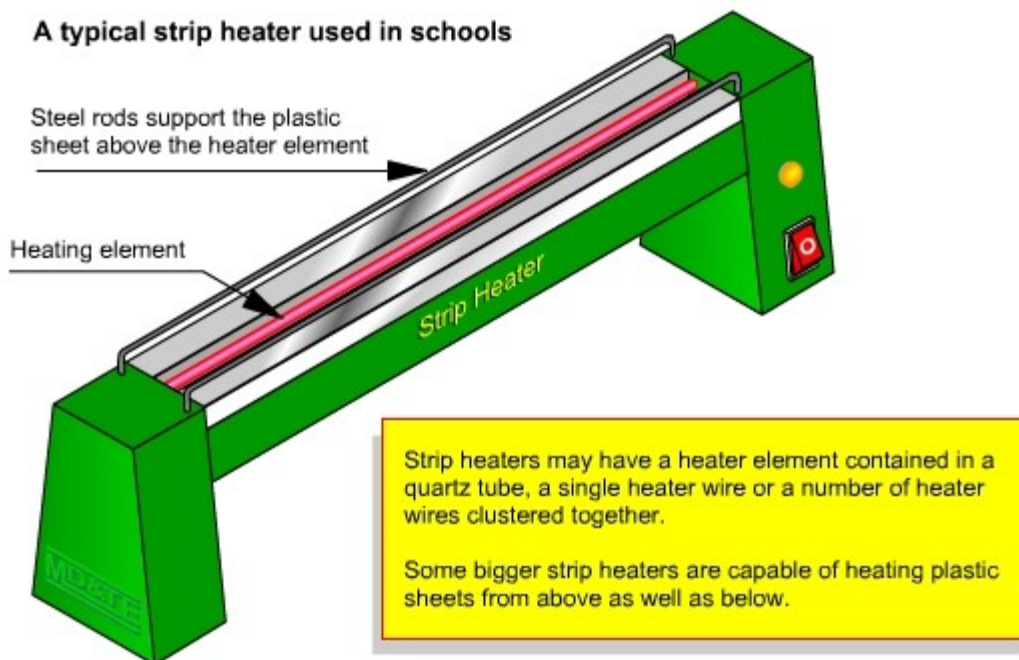
Thermoplastics sheet materials soften when they are heated. When softened, thermoplastics can be bent, twisted and formed in a variety of ways such as by press forming, vacuum forming and by blow moulding.

Various types of heaters are used to heat thermoplastics so that they can be bent and formed, including:

- heaters that heat a narrow strip
- heaters that heat all or most of a sheet of plastic
- heaters that are in contact with the plastic
- heaters that are not in contact with the plastic

For line bending, a narrow strip of plastic is heated. Generally, the thicker the plastic, the wider the heated strip needs to be.

(For vacuum forming, press forming and blow moulding, whole sheets of plastic are heated.)



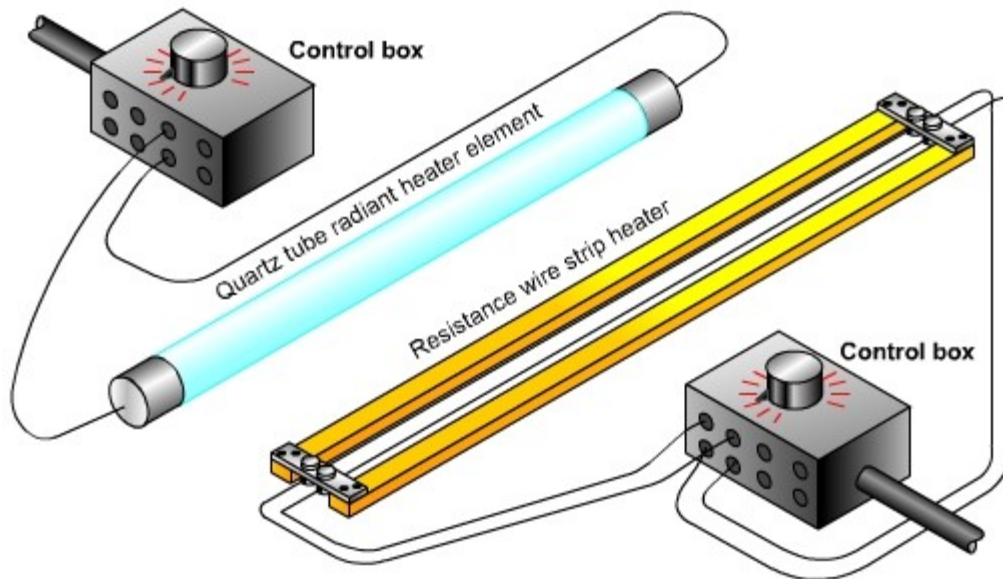
Strip Heaters / Line Benders

Strip heaters, also known as line benders, consist of a resistance wire heating element (such as nickel-chrome resistance wire) that heats up when a controlled amount of current is passed through it.

The heating element may be:

- a single nickel-chrome resistance wire stretched between two terminals
- two or more nickel-chrome resistance wires stretched between terminals
- braided resistance wire
- a coiled resistance wire element enclosed in a quartz, metal or plastic tube.

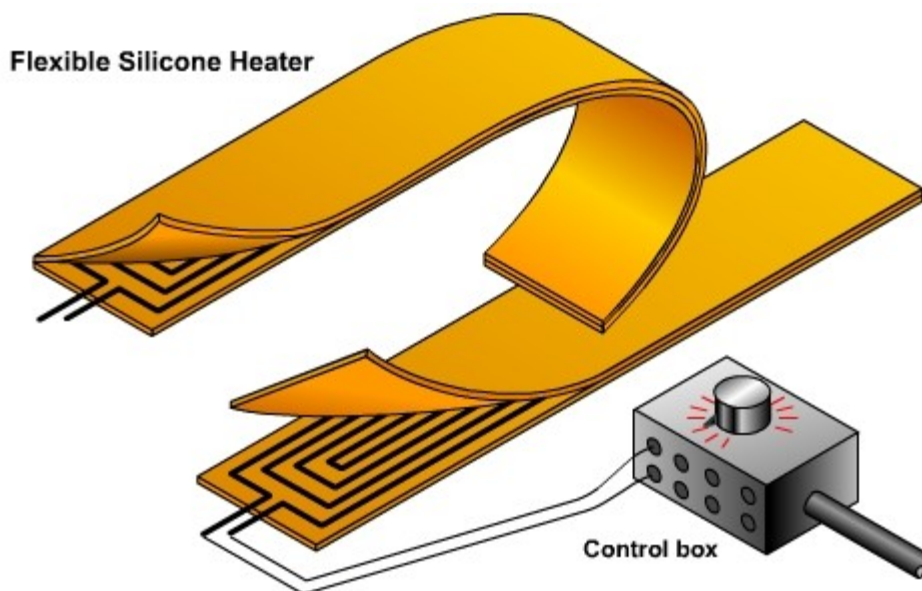
These heaters radiate heat. Thermoplastic sheets are held close to the heating element but are not in contact with it.



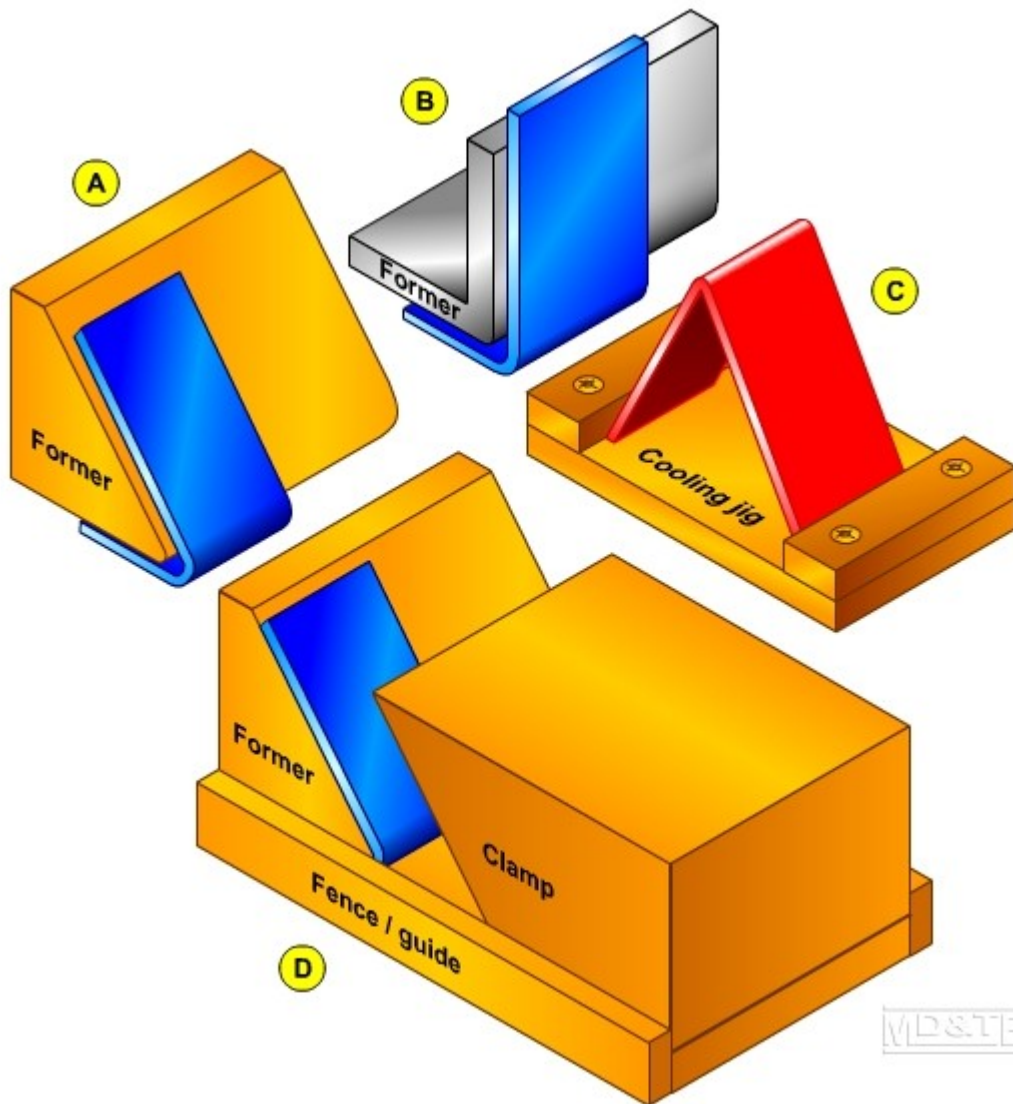
Contact Heaters

Resistance wire heater elements may be encased in a metal or plastic sheath. These heaters are held in contact with thermoplastics. A metal casing with a hatchet profile is used to apply heat directly to a thermoplastic. Resistance wire encased in a metal band may be used to heat thermoplastic and metal rods, tubes and drums.

The diagram below illustrates a typical contact type strip heater consisting of resistance wire sandwiched between sheets of flexible silicone. Flexible silicone heaters may be used on curved as well as flat surfaces.



Jigs for Line Bending



A bending jig is anything that helps us bend metal, wood or plastic to a desired angle. A bending jig used for line bending thermoplastic sheets should include:

- a former that helps us bend a softened thermoplastic sheet to the correct angle
- a clamp that holds the bent thermoplastic sheet until it cools.

Diagram A above illustrates a simple bending former that may be made by chamfering a piece of timber.

Diagram B above illustrates a steel angle bar being used as a bending former. Note that the edges of both jigs have been rounded where the plastic will be bent. To call them jigs, these formers should have a method of holding the bent thermoplastic sheet until it cools.

Diagram C above illustrates a cooling jig that holds a heated and bent thermoplastic sheet until it cools.

Diagram D above illustrates how a simple bending former that has been modified so that it clamps the hot plastic and holds it until it is cool. The former has been converted into a jig.

Plastics Used For Line Bending

Plastic / Polymer	Abbreviation	Description
Polymethyl methacrylate (acrylic) also known as Perspex and Plexiglas	PMMA	Available as sheets and rods, clear and coloured. Examples of use: machine guards, safety screens, display stands, boat windows and hatches, jewellery, signs.
Polyvinyl chloride	PVC	Non biodegradable, leeches harmful chemicals. Examples of use: garden furniture, binders, pens, cling film, buckets, guttering, plastic pipes, window frames, doors, toys, imitation leather, rain coats, bags.
Polycarbonate	PC	Available as sheets, rods and extruded sections. Very light, 1/6th the weight of glass. Very tough. Examples of use: Bullet proof windows, clear roofing, CDs, DVDs, spectacle lenses.
Acrylonitrile-butadiene-styrene	ABS	Chemical resistant, tough with good impact strength Examples of use: automobile instrument panels, radiator grills, fittings for construction industry, pipes, sewing machines, boats, mobile homes, computers, radios, TVs, telephones.
Polyethylene terephthalate copolymer	PETG	Available as sheets and extruded sections. Stronger than acrylic, less strong than polycarbonate. Examples of use: medical, electronic and food packaging, packaging for soft drinks, bottled water, fruit-based beverages and iced teas.
Polystyrene	PS	Available in sheet and extruded sections. Examples of use: disposable cutlery, plastic model cars, toys, CD and DVD cases, cases for electronic products, rulers, combs. Also used as expanded polystyrene, for packaging, insulation, composite with concrete.
High-density polyethylene	HDPE	Relatively high strength, tough, flexible, has the ability to "relax" under stress. Examples of use: wood-plastic composites, blow moulded hollow goods, garden furniture, automobile fuel tanks, drums, underground pipes, flexible packaging, and household goods.
Polypropylene	PP	Resistant to most forms of physical damage, including impact and freezing, resistant to corrosion and chemical leaching. May be joined by heat fusion. Its resistance to fatigue enables it to be used for flexible (living) hinges. Examples of use: moulded products, bottles, insulation for electric cables, stationary folders. Flip-top bottles, cases and boxes.