Motive Power Cell Technology

Introduction

- Presently within Asia, Europe and North America there are three distinct motive power 2 volt cell footprints , these being:

  British Standard.
  DIN Standard.
  US Standard.

- British and the DIN standards are predominately used within the European Markets whilst the US standard is used within the North America regions. Asia and the Australasia Markets use a portion of all three. The Japanese market is unique as they also have their own standards named JIS which is a combination of both the US and BS standards.

- All three designs are different in terms of WIDTH, LENGTH and PLATE PITCH. Heights also vary within each of the three designs, however, it is fair to say each cell range does have dedicated standard heights available. Other heights are available but are usually to support special applications such as Mining, Train Lighting and special cleaning equipment to name a few.

- The positive plate technology used within these designs are also different. Tubular plates are used predominately within Europe and Flat plate in North America and also some tubular. Tubular technology can also be divided into two distinctive designs these being ROUND or SQUARE tubes.

- Both Flat and Tubular plates very in size in order to meet the need of the application.

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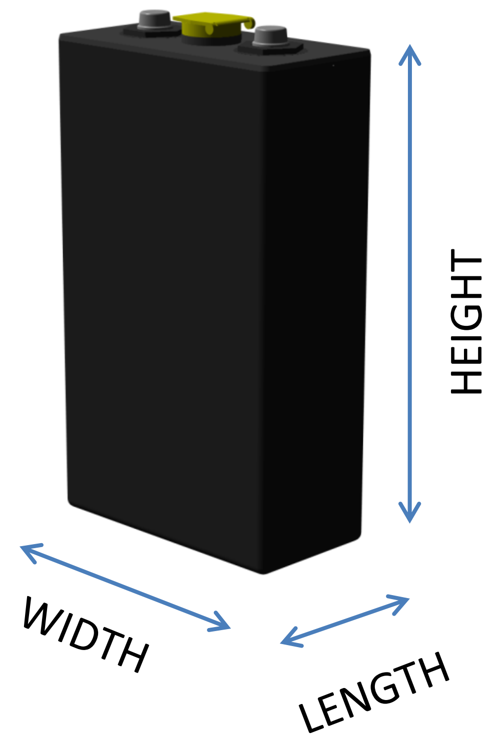
2 VOLT CELL FOOTPRINT TABLES

CELL WIDTH (MM)	BRITISH STANDARD WIDTH - 158 MM													
No OF PLATES	5	7	9	11	13	15	17	19	21	23	25	27	29	31
CELL LENGTH (MM)	46	62	78	94	110	126	142	158	174	190	206	222	238	254
HEIGHTS	TYPICAL - 9 STANDARD HEIGHTS WITH POSITIVE PLATE Ah CAPACITIES OF 32,42,55,65,75,80,86.100 AND 108													
INTERNAL PLATE PITCH	POSITIVE AND INTER NEGATIVE PLATE PITCH OF 15.875MM (5/8")													

CELL WIDTH (MM)	DIN STANDARD WIDTH - 200 MM													
No OF PLATES	5	7	9	11	13	15	17	19	21					
CELL LENGTH (MM)	47	65	83	101	119	137	155	173	191					
HEIGHTS	TYPICAL - 9 STANDARD HEIGHTS WITH POSITIVE PLATE Ah CAPACITIES OF 50,60,80,90,105,115,125.140 AND 155													
INTERNAL PLATE PITCH	POSITIVE AND INTER NEGATIVE PLATE PITCH OF 19.05MM (3/4")													

CELL WIDTH (MM)	USA (BCI) STANDARD 157 MM					USA (BCI) STANDARD 159 MM								
No OF PLATES	5	7	9	11	13	15	17	19	21	23	25	27	29	31
CELL LENGTH (MM)	51	70	89	108	127	146	165	184	203	222	241	260	279	298
HEIGHTS	TYPICAL - 5 STANDARD HEIGHTS WITH POSITIVE PLATE Ah CAPACITIES OF 55,75,85,100 and 125													
INTERNAL PLATE PITCH	POSITIVE AND INTER NEGATIVE PLATE PITCH OF 19.05MM (3/4")													

CELL WIDTH (MM)	JAPANESE (JIS TYPES) STANDARD WIDTH - 158 MM													
No OF PLATES	5	7	9	11	13	15	17	19	21	23	25	27	29	31
CELL LENGTH (MM)		60/57	75/78	94	109	128	142/44	186	177	161/190	206/208	225	244	
HEIGHTS	TYPICAL -15 HEIGHTS WITH VARIOUS POSITIVE PLATE Ah CAPACITIES													
INTERNAL PLATE PITCH	POSITIVE AND INTER NEGATIVE PLATE PITCH OF 19.05MM (3/4") or 15.875MM (5/8")													



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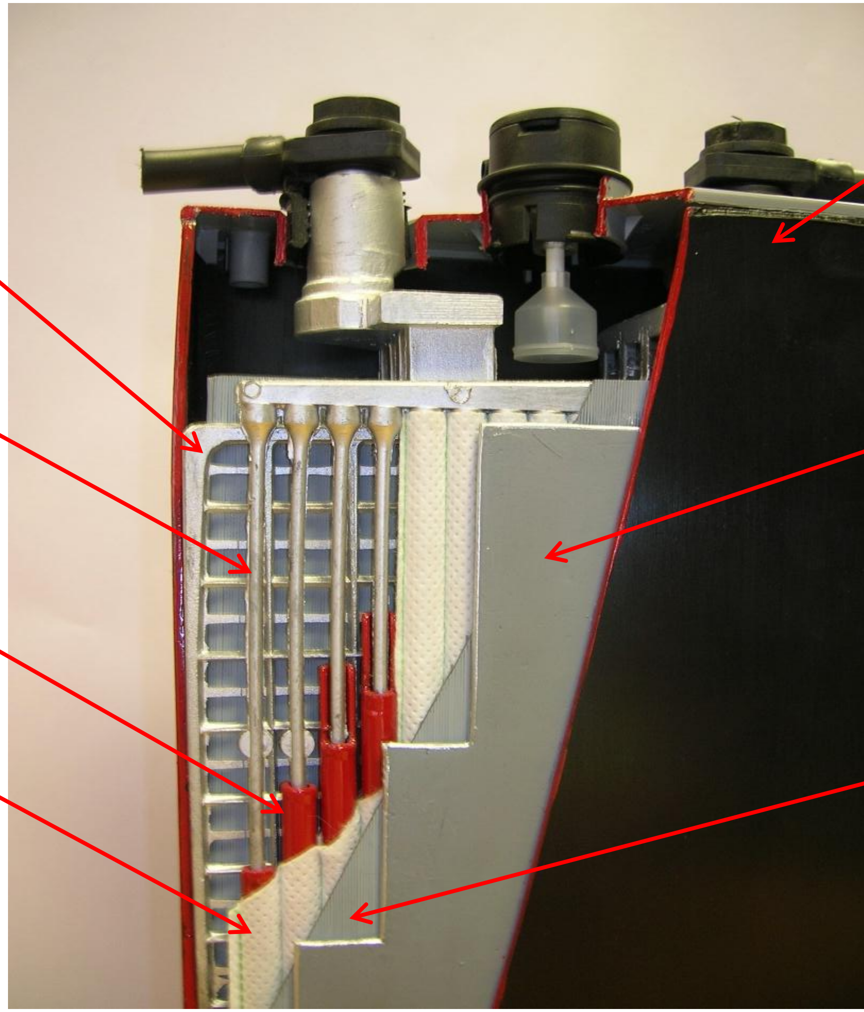
Positive Plate Technologies – Tubular Plate Overview



Negative lead alloy grid

Lead alloy positive Spines

Positive active material

Polyester fabric gauntlet provides retention of the active material

General construction heat sealed polypropylene lid to box with lead posts with seals to prevent electrolyte leakage.

Negative flat plate pasted grid

Micro porous separator sleeves surround the positive plate to provide insulation between the positive and negative plates while allowing the free flow of electrolyte throughout the cell

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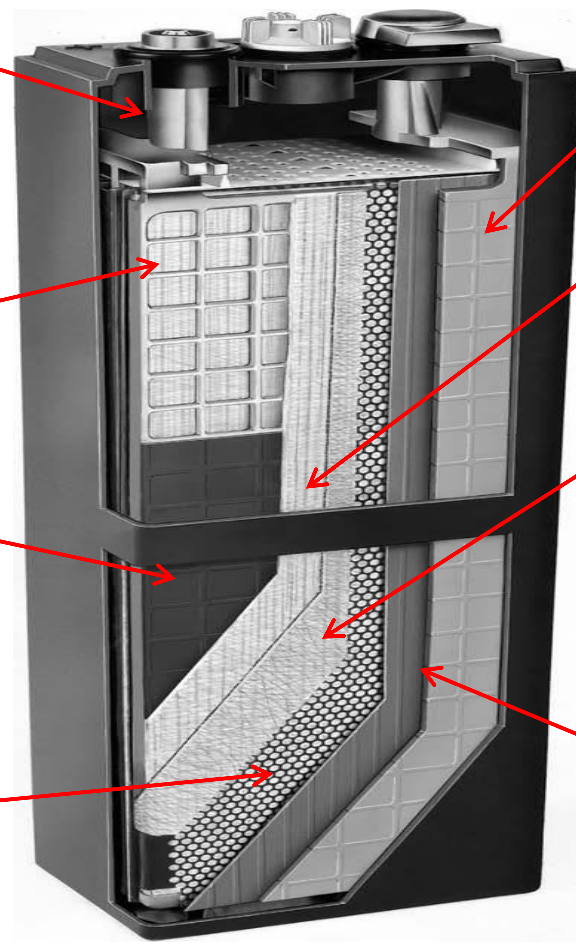
Positive Plate Technologies – Flat Plate Overview

General construction heat sealed polypropylene lid to box with lead posts with seals to prevent electrolyte leakage.

Positive flat plate lead alloy grid.

Positive flat plate pasted grid

Perforated plastic envelope which encases the positive plates and glass mats to prevent shorts.



Negative flat plate pasted grid

Vertical glass mat that in beds the positive active material to ensure retention of the active material

Horizontal glass mat included to break up gas bubbles and to increase the positive plate insulation and performance.

Micro porous separator veneers provide insulation between the positive and negative plates while allowing the free flow of electrolyte throughout the cell

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Design Comparison – Flat Plate v Tubular

- Motive Power Cell Construction

An electrolytic cell by definition is two dissimilar metals submersed in an electrolyte. In the lead acid cell the positive electrode or anode is comprised of lead dioxide PB02 and is the work horse of the battery. The negative plate is sponge lead (PB). In both tubular and flat plate batteries the negative plate is identical in appearance and function. It is the positive plate that differs in design and construction.

- Tubular Plate Construction

A typical example of a tubular plate is shown on the next slide, plates of this type are of a gauntlet construction built up of a number of lead alloy spines connected to a lead alloy top frame (top bar) this also includes the plate lug. The spines are centralised by means of fins integral with the spine in a multi tubular non woven fabric sleeve or gauntlet.

Each annulus is filled with the active material which makes intimate contact with the supporting spines. The active material is tightly packed into the tube and when fully formed becomes solid but highly porous making a perfect electrical contact with the spines which, in turn, conduct the current to the terminals. The electrolyte is permitted to penetrate freely, whilst the tubular sleeve acts as an effective retainer for the active material. This type of construction provides for the highest output per unit volume

- Flat Plate Construction

The flat plate positive is made up of a grid and active material. The grid is cast from and alloy of lead and antimony. The horizontal and vertical members are called wires and are connected to the frame as shown on the following slides. The active material when pressed into the grid results in a mechanical interface at the grid wires and frame. This extrusion process yields flat surfaces on both sides of the plate.

A diagrammatic comparison of Tubular and Flat plate designs is illustrated on the next few slides

- Separation

Both tubular and flat plate cells require adequate separation of the positive and negative to prevent short circuit and hence premature life failure. The design and construction of the separator is very important and present types and designs are discussed further in this presentation.

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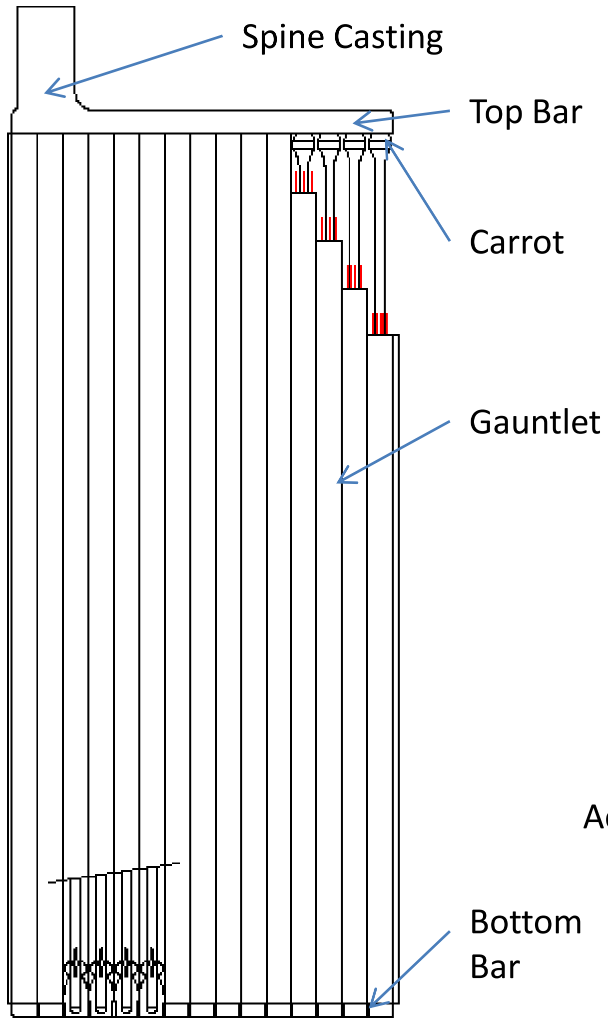
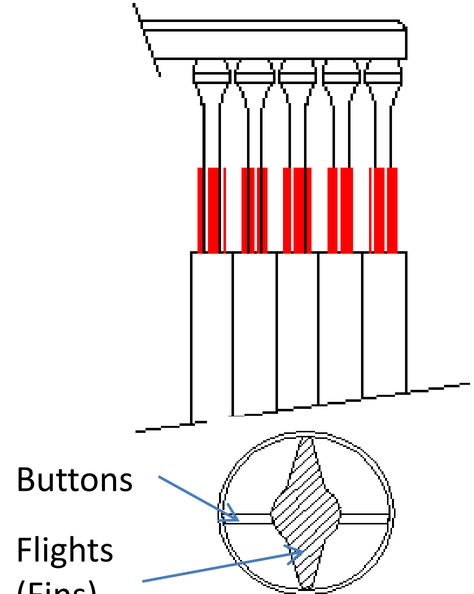
CONSTRUCTION DETAILS OF TUBULAR POSITIVE PLATES



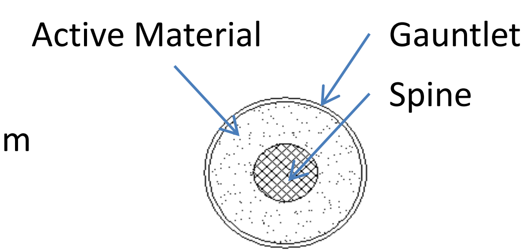
The Importance Of Tubular Design

The positive plates are of a gauntlet construction built up of a number of lead alloy spines connected to a lead alloy top frame (top bar) this also includes the plate lug. The spines are centralised by means of fins integral with the spine in a multi tubular non woven fabric sleeve or gauntlet.

Each annulus is filled with the active material which makes intimate contact with the supporting spines. The active material is tightly packed into the tube and when fully formed becomes solid but highly porous making a perfect electrical contact with the spines which, in turn conduct the current to the terminals. The electrolyte is permitted to penetrate freely, whilst the tubular sleeve acts as an effective retainer for the active material. This type of construction provides for the highest output per unit volume



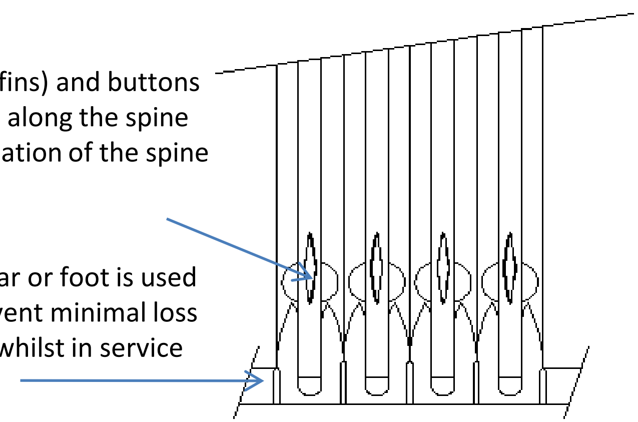
Details of Sine Centralisation



Details of Tube Profile

A series of flights (fins) and buttons are equally spaced along the spine to ensure centralisation of the spine with the gauntlet.

A plastic bottom bar or foot is used at the base to prevent minimal loss of active material whilst in service



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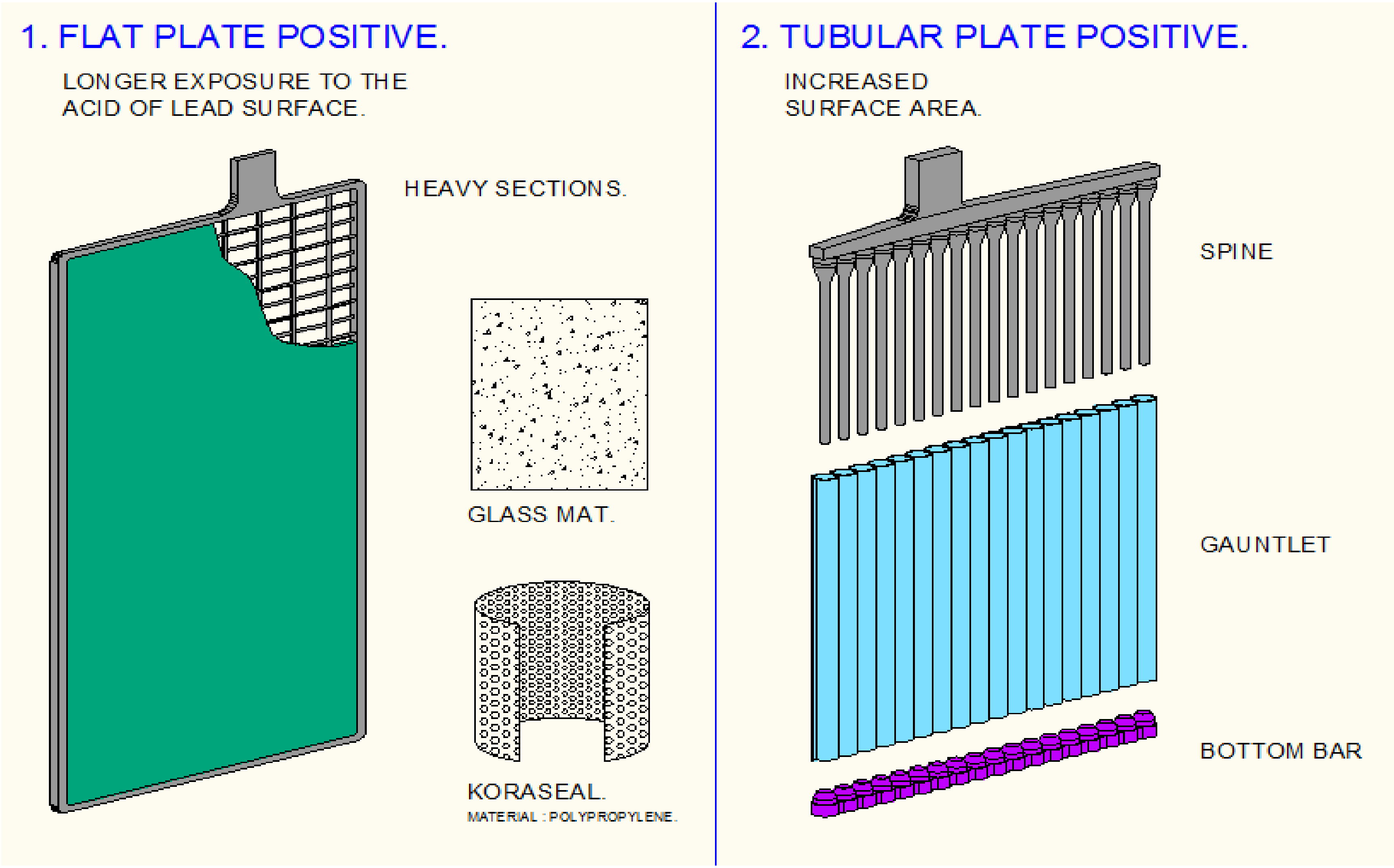
Design Comparison – Flat Plate or Tubular



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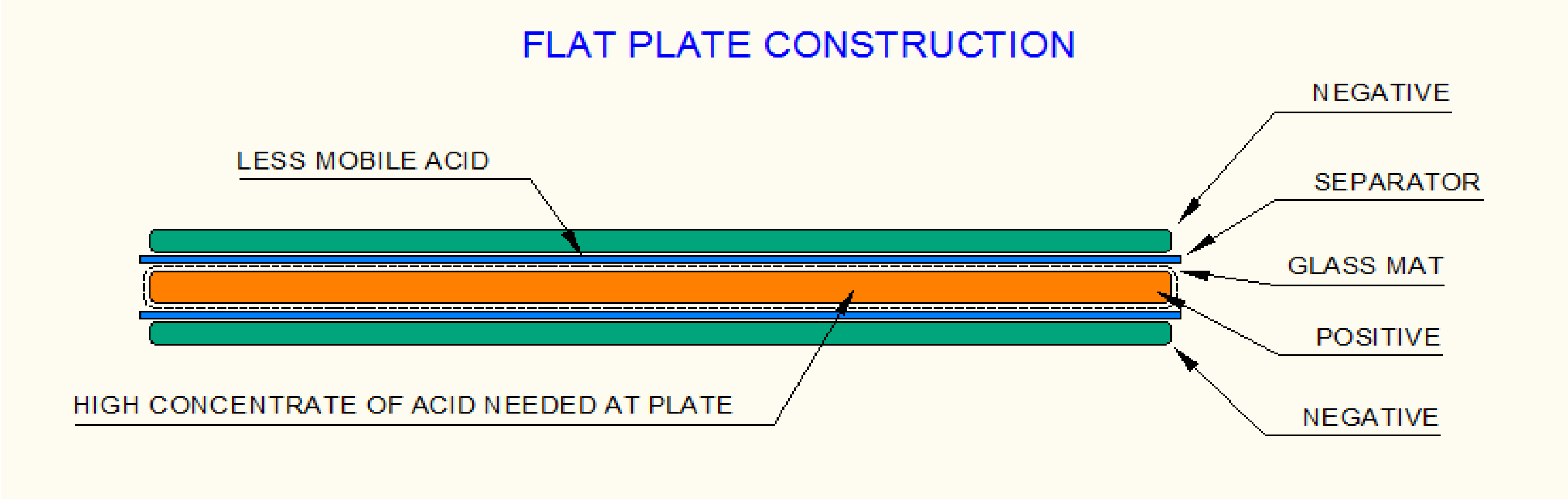
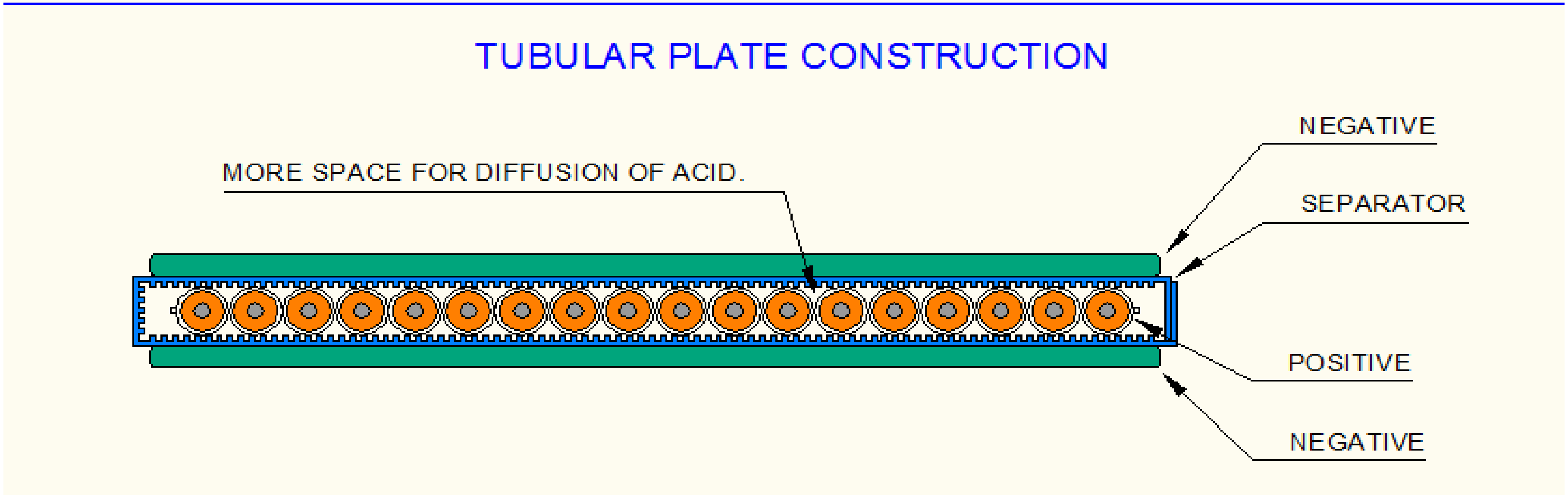
Design Comparison – Flat Plate or Tubular





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Separators

Objective

- The main objective of the separator is when placed between two plates of opposing polarity is to prevent electrical short circuits while allowing ionic current to flow through the separator.

Properties and design requirements of a Motive Power Separator

- Back Web Thickness and Rib Configuration

  The design or choice of the separator profile is very important to the performance of the cells. The rib configuration and the rib pitch specified needs to be accurate as these ribs support the active mass and provides extra space for the electrolyte. The back web thickness makes a significant contribution to the electrical resistance. Some commonly used profiles utilised presently within the Industry are shown in Appendix 1. Typical rib profiles available are VERTICAL, DIAGONAL and SINUSOIDAL.

  The design of the separator is subject to the application and the cell construction. We have to consider the positive plate and the overall cell design. The previous slides have given an indication of the variety of cell designs we have to consider and accommodate. In addition, attributes such as life expectancy, high or low discharge rates and the method of battery assembly / separator manufacturing and equipment used will dictate the basis of the separator material and its dimension requirements.

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Separators

Properties and design requirements of a Motive Power Separator

- Back Web Thickness and Rib Configuration

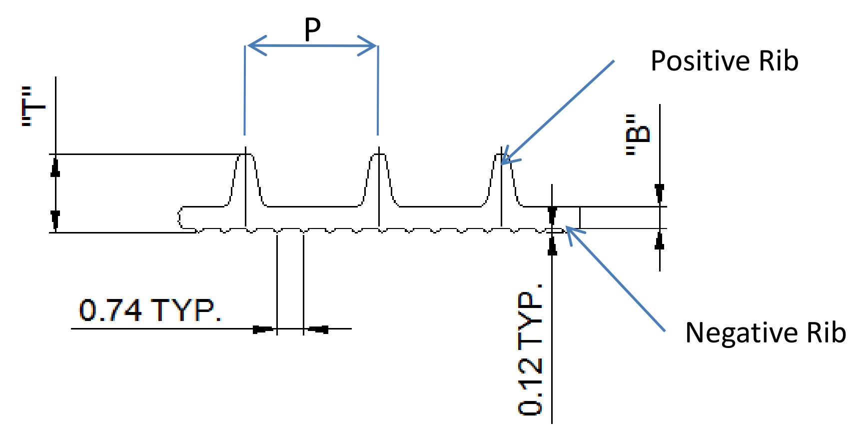
  As previously mentioned rib design and pitch of the ribs is very important. Rib contact with the tube profile to support the tubes must be maintained. The optimised space created between the tubes and the back web due to the positive rib positions allows electrolyte circulation and the release of gasses whilst on charge. Gas trapping within a cell can reduce the life expectancy.

  Although the design and positioning of the positive ribs are important we must also consider the interface between the separator and the negative plate.

  The interface profile between the separator and negative is a series on cannelure ribs or mini ribs. These small ribs can improve battery performance by providing more space between the negative plate and the separator which promotes electrolyte and gas circulation. These ribs also provide some retention of the acid which keeps the separator and plates wetted.

  A profile illustration is provided below :

T = Overall Thickness
B = Back Web Thickness
P = Positive Rib Pitch



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Separators

Properties and design requirements of a Motive Power Separator

- Back Web Thickness and Rib Configuration

The two main separator constructions used within the motive power industry in terms of assembly are either sleeves or veneer alternatives. Sleeves can be assembled around the positive or negative plates and provide protection against short circuits to the edges of the plates. Veneers are basic flat sheets which provide protection of the plates face to face but don’t provide any edge protection for short circuits.

Where a veneer is the chosen separation method then further provisions to protect from edge shorts need to be considered. One method used is to apply a protective adhesive to the end tubes of the positive plate gauntlet

Within the industry today it is fair to say that for Motive Power the choice of material used is either Polyethylene based or PVC. The choice of material will reflect the manufacturing capabilities of the Battery Manufacturer.

Polyethylene has excellent strength properties but is also flexible and so is the preferred material for the manufacture of Motive Power Separator Sleeves.

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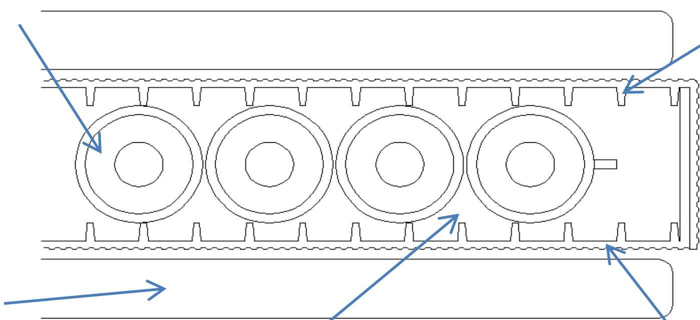
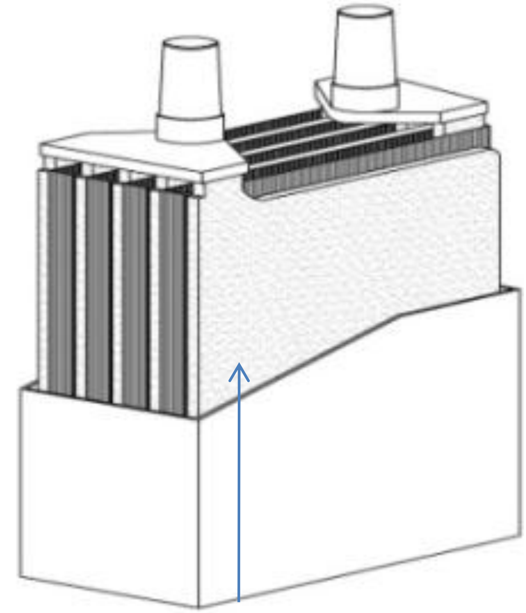
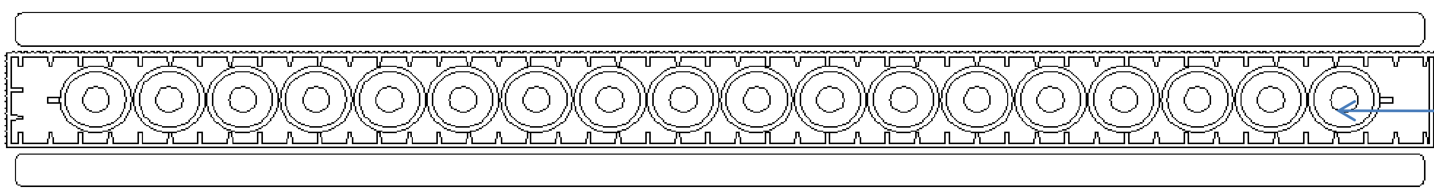
Separators

Example of Sleeves around the Positive Tubular Plate







Typical Positive Sleeved Assembly

Although the design of the profile is of the upmost important other properties required of a Motive Power Separator are:

- Electrical Resistance
- Volume , Porosity and Pore Structure
- Chemical Purity
- Oxidation Resistance
- Manufacturing Requirements and Handling

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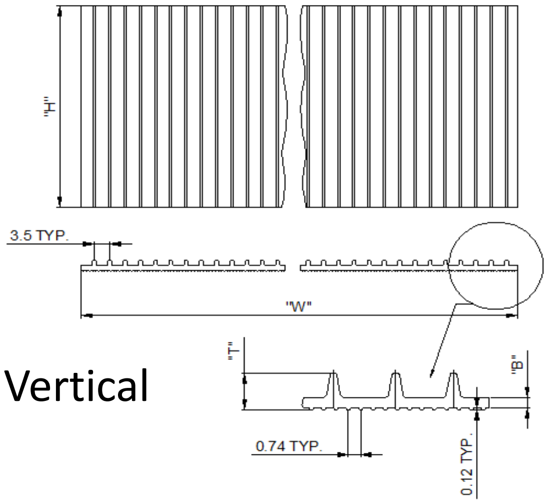
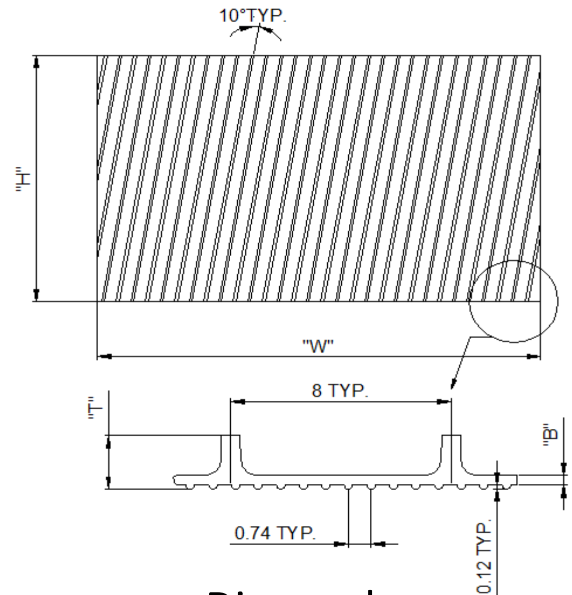
Separators - Profiles

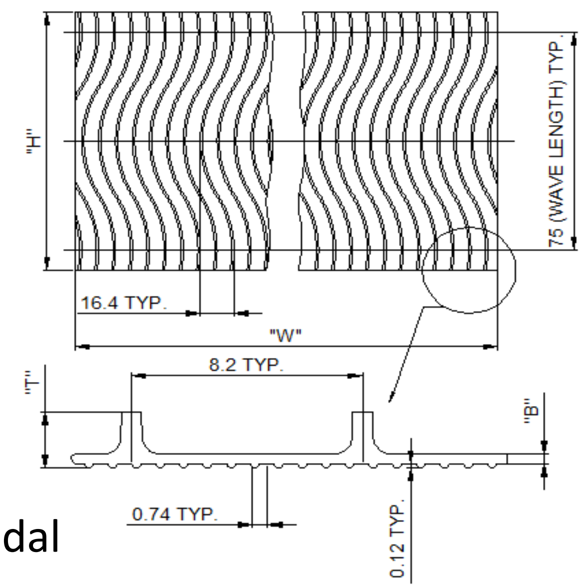
Separators can be obtained in various lengths and widths. Can be supplied as flat individual sheets or in roll form.



Vertical

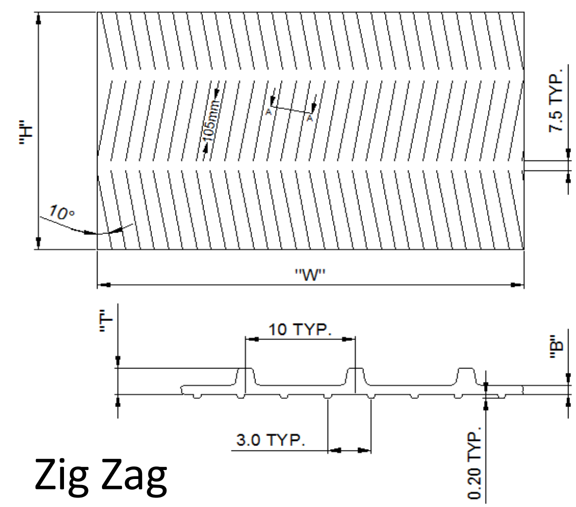


Diagonal



Sinusoidal

Overall thickness , back web and rib pitches can be provided to suit the application and the battery manufactures plate designs



Zig Zag