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3. PROCESS SPECIFICATION P.S. 1F TACKLESS.
TANK FORMATION OF AUTOMOTIVE PLATES USING
THE TACKLESS SYSTEM

(Current as at December 1986)

CHLORIDE

PRINCIPLES OF TANK FORMATION

After the pasting, curing and setting processes, both the positive and negative plates consist essentially of lead oxides, basic lead sulphates, a small amount of residual lead and moisture, and the relevant additives.

The process of tank formation electrochemically converts unformed plates into easily recognisable formed positive and negative plates, the process taking place in the presence of dilute sulphuric acid. The positive active material is lead dioxide, dark brown/black in colour and quite porous. The negative active material is spongy lead, grey in colour and is also porous.

During the formation process, the positive and negative plates become charged relative to each other and set up a voltage opposing the voltage from the rectifier (applied voltage). Therefore as the process proceeds:-

(a) Using a Constant Voltage Source - This will result in the current, actually going through the plates, being reduced, or

(b) Using a Constant Current Source - The applied voltage must rise to compensate for the opposing voltage generated by the plates.

For tank formation CHLORIDE use Constant Current. As the opposing voltage rises during the schedule, the rectifier voltage rises (automatically in most cases) by means of a variable resistance ensuring that the current through the circuit remains constant.

The theoretical electrical energy required for the process can be calculated from Faraday's laws using electrochemical equivalents. In practice the efficiency is only around 50% and hence the Ampere hours required for the conversion are considerably more than the theoretical values calculated. This is due to the fact that a portion of the electrical energy that is used in overcoming the resistance in the circuit (plates etc) is dissipated as heat. Also a large portion of the electrical energy is wasted due to the large amount of gas evolved during the process.

Furthermore the actual Ampere hour input required will vary with the composition of the paste which in turn will depend on various factors including the quality of oxide used, the formulation of the paste and the efficiency of mixing, and the quality of the curing and setting process.

Using standard CHLORIDE paste mixes and processes it has been established that 16.5 Amps are required to convert each kilogram of dry unformed positive material and this figure is used in establishing the formation schedule.

In practice the conversion is not carried out to completion and at the end of the given schedule, the positive active material usually consists of 80 - 90% lead dioxide (PbO_2) whilst the negative active material consists of 90 - 95% spongy lead (Pb).

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(November 1986)

CHLORIDE

TACKLESS FORMATION (EQUIPMENT ETC)

The old conventional method of connecting plates together in tank formation was to tack positives together using a separate lead banding strip, and to tack the negatives together using another lead banding strip. This system was both labour and material intensive, the actual tacking operation was a skilled job and the casting of lead strips was a full-time job.

The introduction of Tackless Formation eliminated the tacking operation, eliminated the need for separate lead banding strips, and thereby reduced costs in formation. In addition, the plates are now easier to handle in the ensuing processes because of the absence of the tacking "pip", often previously left on the plate lugs.

Tanks are made from fibreglass and are shaped so that internally they have ledges which support the furniture unit. The furniture is made of structural polypropylene foam and comprises a series of grooved plate racks held together by rods, spacers, and nuts, also made of plastic material. The furniture is assembled as a complete unit before being placed in the tank.

A contact bar is provided under each grooved board and these are of a common design being cast in a suitable antimonial lead alloy (e.g. C6X). Risers are burned on before being permanently burned to the lead equalising bars between adjacent tanks. The submerged contact bars are longitudinal V shaped in section and plate lugs rest across the V making contact on both sides. An important feature of the bars is that they are open at the base to permit sediment to fall through to the bottom of the tank, thus avoiding shorts.

On the first run, plates are fed into the grooved boards so that the positives rest on one bar, and the negatives, in between, rest on the opposite bar. There are 21 slots per row and with standard width plates there is room for 3 rows per tank (with narrow width plates there is room for 4 rows per tank). It is normal practice to load 2 castings into each slot of the grooved boards except for the end negatives which are single castings.

Therefore, in a circuit of 40 tanks there are 4800 castings (standard width) or 6400 castings (narrow width).

For the second run, plates are fed into the same slots but this time the lugs rest on the opposite bars, i.e. positives on the bars used in run one for negatives, and negatives on the bars used in run 1 for positives. For this run the polarity of the bars is now reversed, using a simple changeover switch in the D.C. supply system.

The third run will be identical to the first run, and run four will be identical to run two, the direction of the forming current changing each time.

Formation time is 20 hours with no rest periods, thus enabling the circuits to be changed daily.

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(November, 1986)

Process Specification

Chloride Technical Limited

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No. P.S. 1F TACKLESS

Subject TANK FORMATION OF AUTOMOTIVE PLATES USING THE "TACKLESS" SYSTEM

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GENERAL

This specification defines the requirements and method of tank formation of automotive plates by means of a constant current applied across a fixed number of tanks connected in series. This particular specification uses the "Tackless" system.

CONTENTS

1.0 CIRCUIT PREPARATION

1.1 New Contact Bars

Where a circuit contains new bars, the bars shall be polarised at a rate of 100 Amps for 20 hours prior to the loading of plates.

1.2 Warming-Up

If a circuit has not been run for one day, it shall be warmed-up (repolarised) by passing a current of 100 Amps for three hours in the same direction as the last formation run.

If a circuit has not been run for two days or more, it shall be warmed-up by passing a current of 100 Amps for six hours.

These measures are necessary to counteract any "run back" (or discharge) which arises from leaving a circuit standing for one day or more. Repolarising should be carried out with the circuit empty of all plates.

2.0 CIRCUIT LOADING

2.1 All unformed plates for formation shall be hosed down with approved water prior to loading. This is to minimise the hazards of lead oxide dust.

2.2 Positive plates shall be firmly loaded into the notches of the bars negatively formed in the previous run. This is essential.

2.3 Negative plates shall be firmly loaded into the notches of the bars positively formed in the previous run.

The entire loading process shall be carried out as quickly as possible.

2.4 After loading, each tank shall be topped-up with approved water to a height approximately 2.5 cm above the plate lugs.

2.5 Switch over the contact bar polarity reversal switch.

2.6 The current shall be switched on as soon as the circuit is ready, which shall be within two hours of the first plates entering the circuit. Failure to do this may lead to difficulties in removing surface lead sulphate during the formation process.

NOTE: Operation 2.5 should only be carried out immediately prior to operation 2.6.

3.0 FORMATION ELECTROLYTE

3.1 All plates shall be formed in dilute sulphuric acid of initial specific gravity between 1.010 and 1.030 when corrected to 15.6°C (60°F).

3.2 Although the specific gravity of the formation electrolyte is not critical to the formation process, the range given in 3.1 is chosen for the following reasons:-

(a) At the lower end (1.010) there must be sufficient sulphuric acid present to conduct the electric current.

(b) At the upper end (1.030), the limit is applied so as to ensure that, after formation, the plates may be adequately dried without the necessity of first washing down.

3.3 In order to control the specific gravity of the electrolyte within the specified limits, the volume of acid in each tank shall be reduced by syphoning off 10 to 15 cm prior to the loading of plates for the next formation run.

4.0 FORMATION SCHEDULE/RATES

4.1 The formation schedule shall be 20 hours continuous charge at the specified constant current calculated for the particular type of plate.

4.2 The formation rates for all automotive plates shall be calculated using 16.5 Amps per kilogram of dry, unformed positive paste.

4.3 The formation current shall be calculated in accordance to the method given in Appendix 1.

5.0 CIRCUIT CONTROL

5.1 A daily formation record sheet shall be filled in and shall clearly state the plate type, number of plates per circuit (positive and negative), the formation current, and the starting and finishing times of formation. The record sheet shall be kept in the rectifier room.

5.2 The current, as displayed on the rectifier panel, shall be checked hourly and corrected to the stipulated value, if necessary.

5.3 The temperature of at least five tanks per circuit shall be checked every three hours. Should the temperature rise above 65°C then the current must be switched off until the temperature falls below 60°C when the current may be switched on again. Any loss in time shall be added on to the schedule in order that the total number of Ampere hours is maintained.

6.0 UNLOADING

6.1 All plates shall be lifted from the circuit within four hours of completion of the schedule, otherwise a trickle charge of 50 Amps must be maintained to prevent run-back.

6.2 At the completion of the schedule, negative plates shall be unloaded first and hung on rail skids. Plates shall be tightly packed.

6.3 If an inert gas oven is not available immediately for drying the negative plates, then the whole rail skid shall be immersed in approved water to prevent oxidation.

6.4 Negative plates may be kept under water for up to 72 hours, but in emergencies only.

6.5 Positive plates shall be lifted after the negatives and hung loosely on rail skids to aid drying.

6.6 Drying of positive plates shall commence within six hours of lifting from the formation circuit.

6.7 For consistent formation, the period between switch off and switch on again, should be as short as possible.

APPENDIX 1

CALCULATION OF FORMATION CURRENT

The formation current is calculated using the following formula:-

Current (in Amps) = N x W x K

where

N = Number of positive castings per tank
W = Weight of dry, unformed paste per positive casting
K = Amps per kilogram of dry, unformed positive paste.

EXAMPLE

A circuit is loaded with standard X type plates. There are two castings per slot, ten slots per row, three rows per tank.

∴ N = 60

For the standard X2.04, the average wet paste weight

per positive casting = 246 g (from Q.C. records)

∴ Weight of dry paste = $246 \times \frac{87.2}{100}$ (from table of conversion factors)

∴ W = 214.5 g

K (for 20 hours schedule) = 16.5 Amps

∴ Current = $\frac{60 \times 214.5 \times 16.5}{1000}$

= 212 Amps