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CARBURIZING BATH

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The present invention relates to salt mixtures which, when in a molten condition at elevated temperatures, are adapted for carburizing ferrous metal, a bath made from such salt mixtures, and a process of using the bath.

It is an object of this invention to provide a case carburizing bath that will give effective case depths of at least 16 mils in one hour at 1600° F. consistently, but which, at the same time, will not leave an insoluble sludge on the article after it is removed from the bath, oil quenched, and shaken in hot water. It is a further object of the present invention to provide an easy washing carburizing bath operable over a temperature range of 1550° to 1650° F. It is a still further object to provide an inexpensive, novel, and effective activator for such a bath, namely, a hydrated sodium silicate. Still other objects will be obvious from the description of the invention given below.

A cyaniding bath containing unactivated sodium cyanide does not coat the work with insoluble sludges, but is unsuitable as a carburizing bath because it carburizes slowly and gives effective case depths of only about 12 mils at the highest temperature at which it can be operated, namely, around 1550° F., and is further unsatisfactory as a carburizing means since it nitrides the work as well as carburizes it, the case at the surface analyzing about 0.6% C. and about 0.5% N.

The usual liquid carburizing bath provides satisfactory case depths through the activation of calcium and barium salts. Such a bath may give an effective case depth of from 16 mils in an hour at 1600° F. to 125 mils in 16 hours at 1750° F. A disadvantage of a bath activated with calcium and barium salts is that these salts sludge, forming oxides and carbonates that adhere to the article when it is withdrawn from the bath and that cannot be dissolved in hot water, but must be removed from the article by chemical and/or mechanical means.

An easy washing carburizing bath has now been found that incorporates the easy washing characteristics of a cyaniding bath with the high carburizing activity of a calcium salt-activated bath. The bath of the present invention, unlike a cyaniding bath, is operable up to 1650° F. and gives satisfactory case depths even though it contains no alkaline earth activator. The bath of the present invention is further characterized by its high activity in commercial-size pots, its ease of maintaining a good cover, low sodium cyanide loss, and low nitriding.

The bath contemplated in the present inven-

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tion gives effective case depths on fracture up to about 33 mils during a four-hour treatment in the bath, and the film of adherent salts after an oil quench is so soluble that it may be removed simply by shaking the work in hot water a few times. Adherent salts from holes $\frac{1}{8}$ inch in diameter and $\frac{1}{2}$ inch deep are easily removed by such means.

When making up the bath, a salt mixture with the following range of ingredients may be used (parts by weight):

Sufficient parts of a hydrated sodium silicate to provide about 3-8 parts of contained SiO_2

- 15 Sodium cyanide about 17-25 parts
- Sodium carbonate about 25-35 parts
- Graphite (or an organic compound serving as binder in briquettes of bath composition), .3 to 3.0 parts
- 20 Sodium chloride, remainder of bath to give 100 parts total

Various equivalents may be used for the above substances. For example, various other water-soluble cyanogen-forming compounds may be used instead of sodium cyanide, namely, other alkali metal cyanides, cyanates, cyanamides, and the like. Organic cyanogen compounds are also suitable as, for example, cyanamide, dicyandiamide, melamine, melam, melem, melon, ameline, ammelide, hydrogen cyanide polymers, and the like. The sodium carbonate of the bath may be substituted for, in total or in part, by other alkali metal carbonates, and the sodium chloride may be similarly substituted by other alkali metal chlorides. The hydrous sodium silicate may vary widely in its $\text{Na}_2\text{O}:\text{SiO}_2:\text{H}_2\text{O}$ ratio and may be replaced by a hydrous potassium silicate.

Although the quantity ranges listed above are operable and are contemplated by the invention, the following composition represents the preferred materials and their preferred ranges (parts by weight):

- 45 NaCN , 17-20 parts
- $\text{Na}_2\text{SiO}_3 \cdot 5\text{H}_2\text{O}$, 10-15 parts
- Na_2CO_3 , 30 parts
- Graphite, .3 part
- NaCl , remainder to give 100 parts total

- 50 In the following tabulation the performances of various carburizing baths containing hydrated sodium silicates are compared with a bath activated by anhydrous sodium silicate. It will be observed that within certain ranges of silica content, satisfactory case depths, namely 16 to 17

mils, are obtained within one hour. Silicates of various $\text{Na}_2\text{O}:\text{SiO}_2:\text{H}_2\text{O}$ ratios can be used as the hydrous sodium silicate in the bath. For example, bath B in the following tabulation contains a sodium silicate of the approximate formula $\text{Na}_2\text{O}.\text{SiO}_2.5\text{H}_2\text{O}$, whereas bath D contains a hydrous sodium silicate of the approximate formula $\text{Na}_2\text{O}.3.4\text{SiO}_2.2.9\text{H}_2\text{O}$, and bath E contains a silicate of the approximate formula $\text{Na}_2\text{O}.\text{SiO}_2.9\text{H}_2\text{O}$. While any hydrated sodium silicate will provide the desired activation of the bath if present in the quantity sufficient to provide an initial silica content in the bath of from 3-8%, the preferred silicate is sodium metasilicate pentahydrate, because it is the cheapest hydrated silicate on the market.

2. A mixture adapted upon fusion for the carburizing of ferrous metal articles which consists essentially of sodium cyanide 24 parts, sodium carbonate 30 parts, sodium metasilicate pentahydrate 10-15 parts, sodium chloride 40 parts, and graphite .3 part, the parts being by weight.

3. A mixture adapted upon fusion for the carburizing of ferrous metal articles which consists essentially of cyanogen compound 17-25 parts, alkali metal carbonate 25-35 parts, hydrous alkali silicate providing about 3-8 parts of contained silica, carbon .1-3 parts, and alkali metal chloride to make 100 parts, the parts being by weight.

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Composition of Starting Bath, Per Cent	Performance of sodium silicate activated carburizing baths at 1600° F.							
	A	B	C	D	E	F	G	H
NaCN.....	19	24	24	19	19	23	19	24
Na ₂ CO ₃	33	31	30	31.5	28	28	28	24
NaCl.....	42	40	36	42	31	38	38	32
Graphite.....	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Sodium silicate.....	6	5	10	7.5	22	15	15	20
analyzing:								
Na ₂ O, per cent.....	23.3	29.1	29.1	19.4	21.8	29.1	29.1	29.1
SiO ₂ , do.....	75	28.1	28.1	62.5	21.1	28.1	28.1	28.1
H ₂ O, do.....		42.8	42.8	17.5	57.1	42.8	42.8	42.8
Per cent SiO ₂ in starting bath.....	(4.5)	(2.1)	(4.3)	(4.7)	(4.7)	(6.4)	(6.4)	(8.6)
Time, Hours	Effective case depth on fracture in mils after NaCN content of bath has fallen to 17.5%							
	A	B	C	D	E	F	G	H
1/4.....	10	10	12	11	12	11	12	9
1.....	14	14	16	16	16	16	17	15
2.....	18	17	22	20	20	22	24	20
3.....	25	22	27	26	26	27	29	24
4.....	29		31	30	29	32	33	28
1.....	Total case depth, microscopic							
	16		18	19	19	19	19	17

While the invention has been described with particular reference to specific embodiments, it is to be understood that it is not to be limited thereto but is to be construed broadly and restricted solely by the scope of the appended claims.

I claim:

1. A mixture adapted upon fusion for the carburizing of ferrous metal articles which consists essentially of alkali metal chloride 25-45 parts, cyanogen compound about 17-25 parts, alkali metal carbonate 25-35 parts, hydrous alkali silicate providing 3-8 parts of contained silica, and carbon .1-3 parts, the parts being by weight.

REFERENCES CITED

The following references are of record in the file of this patent:

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