Pack Carburizing

Carburizing Medium and Compounds

The basic component of the carburizing medium is ground wood charcoal (approximately 3 to 5 mm, or 0.12 to 0.20 in., granules) or coke, which is mixed with carbonates of barium, sodium, calcium, lithium, or potassium. The common commercial carburizing compounds are reusable and contain 10 to 20% alkali or alkaline earth metal carbonates bound to hardwood charcoal or to coke by oil, tar, or molasses. Barium carbonate is the principal energizer, usually comprising approximately 50 to 70% of the total carbonate content. The remainder of the energizer usually is made up of calcium carbonate, although sodium carbonate and potassium carbonate also may be used. It should be noted that barium carbonate, now designated by government regulations as a health hazard due to its toxicity and the disposal problems it presents, is gradually being phased out by U.S. manufacturers as a catalyst in pack-carburizing operations.

Hardwood charcoal is more reactive than coke as a source of carbon for pack carburizing. Nevertheless, coke offers certain advantages, such as minimum shrinkage, good hot strength, and good thermal conductivity. More-active carburizing compounds therefore contain both charcoal and coke, with typical compounds containing a greater percentage of coke.

Addition Rate. Because of losses associated with the use of pack-carburizing compounds, new compound usually is added to the used compound before it is returned to service. The loss in energizer normally is somewhat higher than loss of the rest of the compound. Therefore, somewhat larger percentages of new compound are used to ensure that the energizer level does not drop below approximately 5 to 8%. When direct quenching or severe mechanical handling methods are used, the addition rate may be as high as one part new compound to two parts used compound. When furnace cooling and careful handling methods are used, the addition rate may be one part new compound to three to five parts used compound.

Used compound often is screened to remove fines. The compound is then thoroughly mixed with the make-up material. Because many compounds, particularly those of the coated-charcoal type, are extremely friable, they require careful handling to minimize losses due to formation of dust or fines.

Evaluation of Carburizing Compounds. Evaluation of compounds can be done by subjecting a specified weight of compound to a series of standardized carburizing cycles, treating a new steel sample in each sample until the carburizing potential of the compound is depleted (indicated by shallow case depths). Four batches of unused carburizing compound (Table 2) received over a period of six months from various manufacturers were evaluated to determine whether they would be suitable for addition to the hoppers that supplied boxes used in pack carburizing gears, pins, shafts, and special washers to a case depth of 1.5 mm (0.060 in.), in continuous furnaces. Weight, screen analyses, and chemical analyses of the as-received compounds are shown in Table 2.

Table 2 Evaluation of pack-carburizing compound

Item	Batch number			
	1	2	3	4
Physical data				
Weight, lb/ft^3	28.0	32.6	38.6	41.0
Fineness, percentage through:				
0.371 in. screen	99.9	99.9	99.3	99.4
0.131 in. screen	0.1	1.0	1.0	0.4
0.100 in. screen	0.03	0.5	0.2	0.2
Chemical analysis, %				
Moisture	0.2	0.2	0.2	0.2
Sulfur	1.05	0.4	0.6	0.7

Sodium carbonate	Nil	Nil	Nil	Nil
Barium carbonate	12.2	9.2	11.5	11.1
Calcium carbonate	Nil	Nil	Nil	Nil
Charcoal	Nil	Nil	0.2	Nil
Coke	87.8	90.8	88.3	88.9
Ash	9.0	7.4	8.1	8.2
Total weight loss during 20 carburizing runs, % (See Fig. 2 for cumulative record for batches 1 and 3)				
By shrinkage	47.2	38.5	34.2	35.8
By blowing out dust	10.9	8.3	12.7	14.2
Total weight loss	58.1	46.8	46.9	50.0

Carburizing tests were conducted on the four compounds as follows. A sample of 1020 steel, 50 mm (2 in.) long and 16 mm (⅝ in.) in diameter, was packed with approximately 600 g (21 oz) of unused compound in a laboratory carburizing box, subjected to a standard cycle of 9 h at 925 °C (1700 °F), and furnace cooled. The test was repeated 19 times with a new steel sample for each cycle, without adding fresh compound.

Case depth was determined microscopically after each of the 20 cycles. Variation in case depth and the cycles producing rich cases, acceptable cases, and erratic cases are shown in Fig. 1. In addition, shrinkage was determined by weight loss after each cycle and after blowing out dust after the 20th cycle. Cumulative shrinkage of two batches of pack-carburizing compounds during 20 consecutive 9 h carburizing cycles at 925 °C (1700 °F) is plotted in Fig. 2.

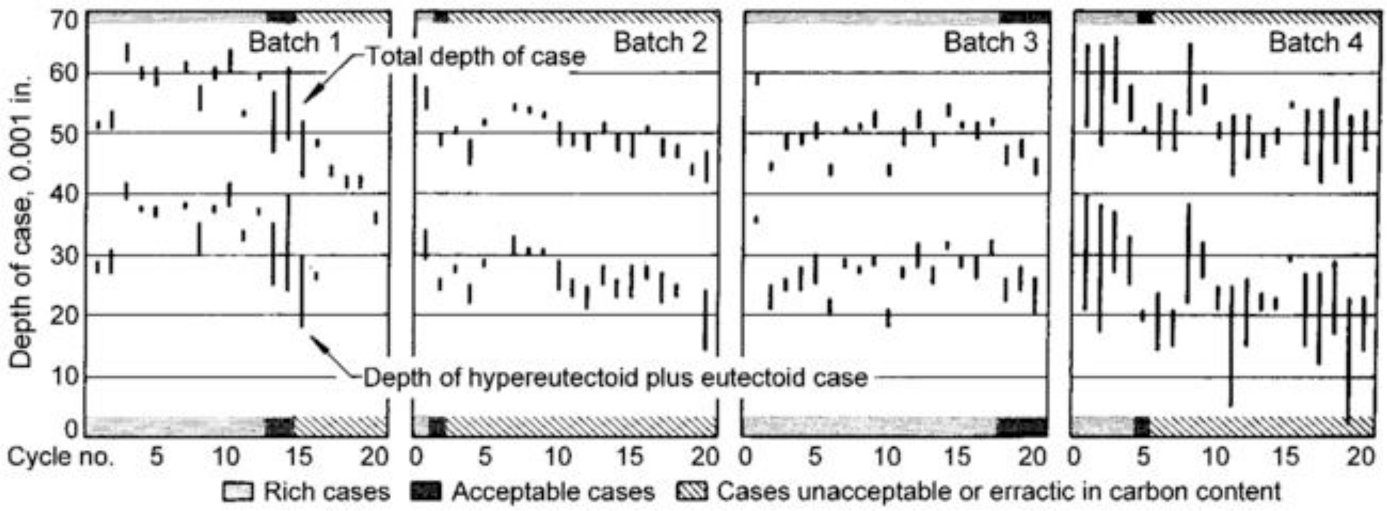

Fig. 1 Variation in case depth produced from 20 consecutive cycles of four different batches of compounds for pack carburizing (Table 2)

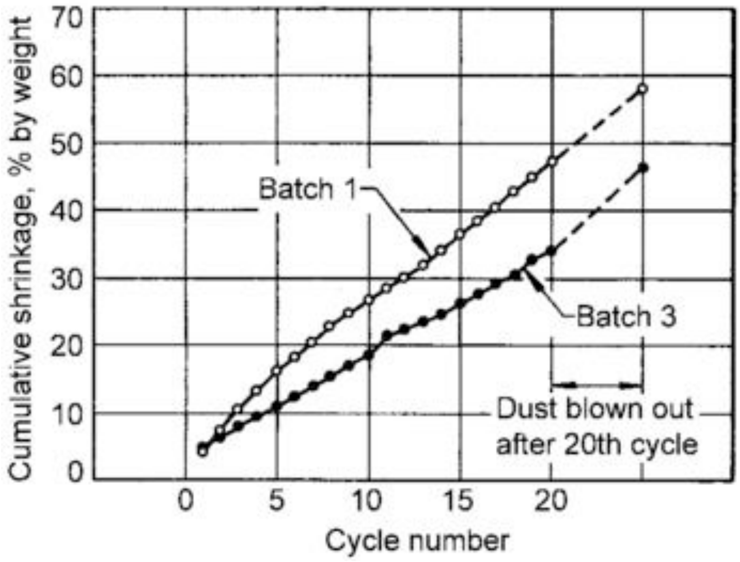

Fig. 2 Cumulative shrinkage of two batches of pack-carburizing compound during 20 consecutive 9 h carburizing cycles at 925 °C (1700 °F). Dust was blown out after the 20th cycle. Shrinkage for batches 2 and 4 (Table 2) was intermediate to the data shown for batches 1 and 3.