HOTSEAT

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Heat treating is all about using the most cost-effective process.

GEARS COME IN ALL SHAPES AND SIZES, made by a myriad of methods: forged, cast, PM, etc. Virtually all methods require heat treating of some kind. When the cost of making gears is itemized by raw materials, machining, and heat treating, the greater quantity that can be made without interruption determines the individual cost.

There's a major advantage heat treating has over other manufacturing steps: hundreds can be processed simultaneously, distributing the cost over the entire lot. That cost may not be a "product-killer" to an OEM with in-house heat treating. However, it's the competitive advantage for the commercial heat treater. Quenching can be the spoiler, but the majority of gears can still be oil quenched in racked fixtures.

Heat treating is about using the most cost-effective process: endo gas; nitrogen methanol; LPC; continuous; or batch. After this, one must create the recipes to achieve the proper ECD (effective case depth) and choose the best temperature and quenching method to reduce carburizing time. Once the process determinations are made, operating cost becomes the most important parameter—one that stays with the purchaser long after the initial capital expenditures are made, and one that can directly affect the bottom line.

The following examination (continued in subsequent columns) will identify and compare the cost to operate a UBQ integral quench carburizing furnace using endo gas with the following configuration:

- 36" W x 48" L x 36" H load size
- 3,500 Lb. (1,588 Kg) capacity
- 3,500 gallons (13,249 L) of quench oil
- Post quench washer
- Temper 800°F (427°C)
- Transfer car
- Endothermic generator

Several levels of automation can manage the load of parts through the heat treat cell. A computer and or PLC (Programmable Logic Controller) are the catalyst that provides the intelligence. The simplest semi-automatic control scenario, a smart car, removes a loaded tray of parts from the "green" queue and transports it to the furnace, washer, temper, and finally to processed storage tables.

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For this discussion, I've taken the detailed cost as explained on a spreadsheet that breaks down every drive and fan motor, gas function, and heating element used per equipment type. The data is presented in cost per recipe, per hour, and cost per net pound processed, and is based on the following utility rates:

- Natural gas, $0.60 / therm, [100,000 BTU] (105,505 kilojoule)
- Electricity, $0.07/kW
- Nitrogen, $0.40/100 CF (2.831 M3)
- Methanol, $4.00/gallon (3.78 L)

PROCESS PARAMETERS:

- 0.060" (1.52 mm) total case depth
- 7446 operating hours per year
- 3000 Lbs. net

CYCLE:

- Load vestibule from charge car, 30 seconds
- Purge vestibule , 10 minutes
- Transfer load to hot zone, 30 seconds
- Heat to 1700°F (926°C) and equalize, 90 minutes
- Carburize with endo gas, 5 hours
- Diffuse and equalize one hour at 1550°F (843°C)
- Oil quench, 12 minutes
- Wash, 15 minutes
- Temper at 350°F (177°C) 3.5 hrs.

DETAILED COST BREAKDOWN:

VESTIBULE & QUENCH TANK	UTILITY	TIME ON (HR.)	COST/ UNIT	$ COST PER RECIPE
Oil pump (1.48 kw)	Electric [kw]	10.74	0.07	0.001
Agitators low speed (2) [5.55 kw]	Electric [kw]	10.74	0.07	4.17
Agitators high speed (2) [11.1 kw]	Electric [kw]	0.2	0.07	0.16
Flame screen [175 cfh]	Natural gas [ft3]	0.01	0.006	0.01
Quench oil heat [4 kw] loss at 180°F (82°C)	Electric [kw]	10.74	0.07	3.01
TOTAL				**7.35**

HEAT CHAMBER	UTILITY	TIME ON (HR.)	COST/UNIT	$ COST PER RECIPE
Rear handler [1.48 kw]	Electric [kw]	0.01	0.07	0.001
Heat parts [780 cfh] recuperated	Natural gas [ft3]	1.5	0.006	7.02
Steady state heat loss [195 cfh]	Natural gas [ft3]	10.74	0.006	12.57
Recirculation fan [2.22 kw]	Electric	10.74	0.07	1.66
Combustion air blower [2.22 kw]	Electric	10.74	0.07	1.66
Controls [0.74 kw]	Electric	10.74	0.07	0.55
Heat endo generator enclosure[100 cfh]	Natural gas [ft3]	10.74	0.006	6.44
Make high flow process gas for endo gen. [151 cfh]	Natural gas [ft3]	1.98	0.006	1.80
Make low flow process gas for endo gen. [100 cfh]	Natural gas [ft3]	10.74	0.006	6.45
Gas / air pump for endo gen. [3 kw]	Electric	10.74	0.07	2.25
TOTAL				**40.40**

WASHER	UTILITY	TIME ON (HR.)	COST/UNIT	$ COST PER RECIPE
Spray pump [3.7 kw]	Electric	0.25	0.07	0.064
Holding losses [15] kw]	Electric	10.74	0.07	11.23
TOTAL				**11.87**

TEMPER (800°F, 427°C)	UTILITY	TIME ON (HR.)	COST/UNIT	$ COST PER RECIPE
Heat to 350°F (177°F) (215 cfh)	Natural gas [ft3]	1.50	0.006	1.93
Recirculating fan [3.7 kw]	Electric	3.50	0.07	0.90
Holding losses [54 cfh]	Natural gas [ft3]	3.50	0.006	1.13
TOTAL				**3.96**

GRAND TOTAL COST FOR THE RECIPE	**$63.58**
OPERATING COST PER HOUR	**$5.93**
COST PER NET POUND	**$0.021**