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Fin Fan ® Air Cooled Heat Exchangers – Life Cycle Costs

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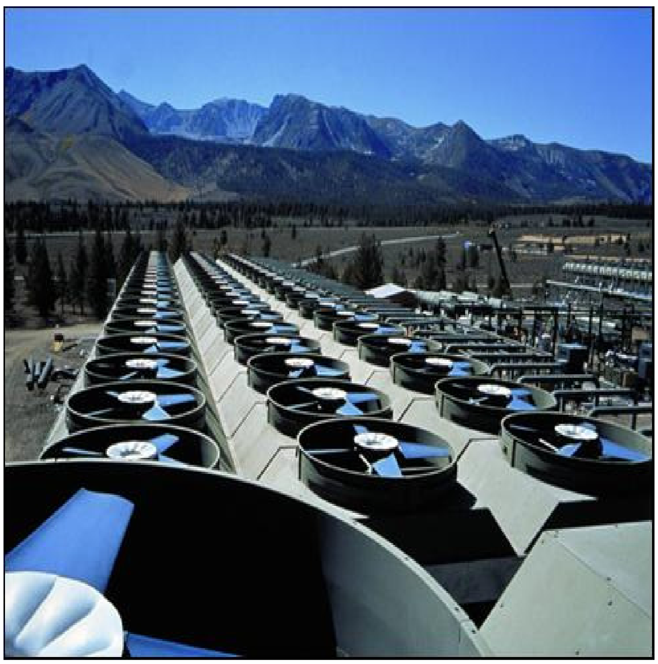

Introduction

Fin-Fan® Air Cooled Heat Exchangers *dominate the plot layout of refineries and petrochemical plants. The failure of this equipment can deplete the profitability of a facility instantly with a failure, or with gradual efficiency erosion over time. Life Cycle Cost (LCC) should be the only measure of importance to a plant owner to avoid expensive retrofitting to correct air cooler component failures. These failures can be detected immediately on start up, or a year or two later, just past the warranty period. The equipment selected for the project must meet the owner's plant investment criteria based on the Lowest Cost of Ownership over the predicted plant life, not lowest initial capital cost. Equipment vendors must be able to demonstrate measurably, the Technical Separation incorporated to ensure owner LCC satisfaction.*

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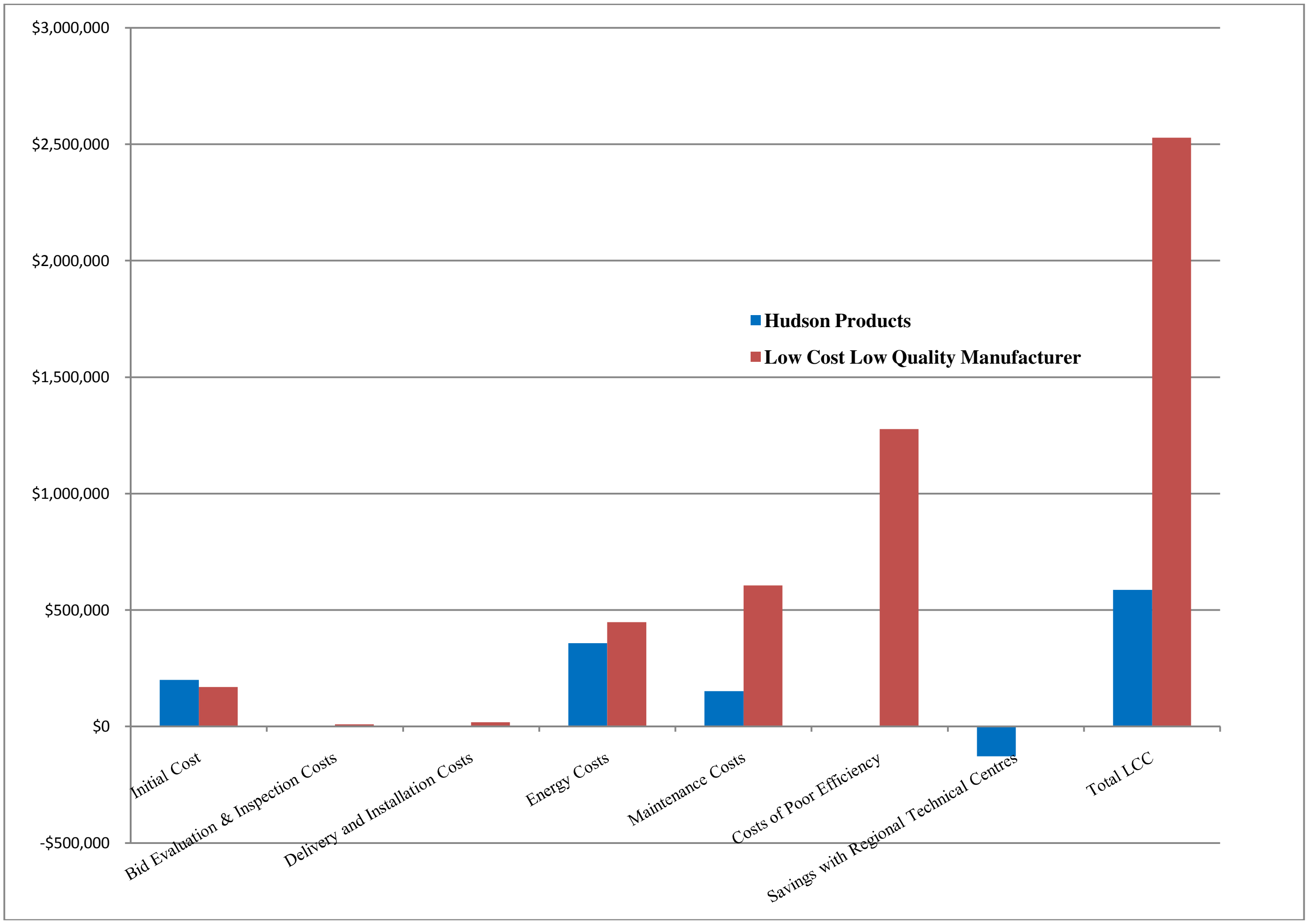
Executive Summary - 20 Year Life Cycle Cost

Hudson Products Corporation = **$586,530**

Low Capital Cost Manufacturer = **$2,528,500**



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Lowest Cost of Ownership – a Life Cycle Cost Analysis

The life cycle cost of any piece of equipment is the total "lifetime" cost for purchasing, installation, operation, maintenance, and disposal.

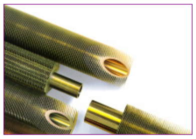
The focus on initial capital cost in recent energy mega projects is creating a lump sum turnkey environment which will potentially impact the end users total cost of ownership long before reaching the plant life and ultimate investment pay out.

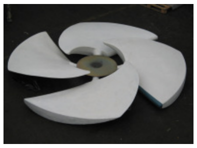
Plant operators worldwide agree on the following **Top 4 Performance Failures**:

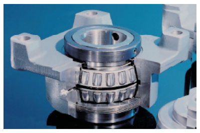
- Finned tubing failures
  - Fin to process tube thermal and mechanical bond degradation
  - Under fin corrosion
  - Fin fouling
- Fan performance failures
  - Poor fan efficiencies
    - Lack of aerodynamic blade shape
  - Cracking and premature failures
- Fan Bearing Failures
  - Use of standard off the shelf bearings leading to premature failure
- Hot Air Recirculation
  - Excessive face velocities

Technical Separation – Hudson® is the Only Air Cooler Manufacturer in the World:

Fins, Fans Bearings







- To Manufacture:
  - Hudson® patented extruded finned tube and Hudson® finning machines
  - Fans (FRP and aluminum) Tuf-Lite® and Cofimco®
  - Fan shaft Fin-Fan® bearings specifically for Air Cooler operating conditions
  - Louvers
  - Auto-Variable® fan control systems

- To Test 1% of all fin tube production for thermal performance
- To Wind Tunnel Test Hudson® Fans for Accurate Fan Curve Publication
- Field Noise Test Hudson® Fans
- To use Computational Fluid Dynamics to Model Hot Air Recirculation

Elements of the Life Cycle Cost Equation

$LCC = C_{ic} + C_{be} + C_{inst}\ C_e + C_m + C_{LP} + C_S$

LCC = Life Cycle Cost
C_{ic} = Initial Cost
C_{be} = Bid Evaluation and Inspection Costs
C_{inst} = Delivery and Installation Costs
C_e = Energy Cost
$C_{m\ =}$ Maintenance Cost
C_{LP} = Cost of Lost Production due to Poor Efficiency of Low Cost Fans and Finned Tubes
C_S = Savings with Regional Technical Centre

Definitions

C_{ic} = Initial Cost

These costs include the engineering, manufacturing, spare parts, and preparation for shipment costs of the air cooled heat exchanger.

C_{be} = Bid Evaluation and Inspection Costs

Low capital cost equipment providers will require additional project bid evaluation hours ensuring specifications are met, along with added inspection costs for low cost shops ensuring adherence to project specifications.

C_{inst} = Delivery and Installation Costs

Units shipped locally as modules will significantly reduce expensive on site construction costs usually hidden in the construction costs and therefore not measurable.

C_e = Energy Cost

The required input fan power formula is:

$$\text{Brake Horse Power (BHP)} = \frac{\text{Actual Fan Static Pressure} \times \text{Air Volume}}{\text{Constant} \times \text{Fan Static Efficiency}}$$

This emphasizes the importance of the **Fan Efficiency** on the air cooler power consumption.

It is important to note that the motor power is proportional to the cube power of the fan flow rate. Once a unit underperforms, a 10 % increase in air flow will require a 33% increase in motor power.

C_{m} = Maintenance Cost

Conventional bearings are not suitable for arid, high ambient climates. Bearing lifecycles are reduced causing outages, and lost production. Poor quality fans will crack and fatigue in the extreme GCC heat with safety implications, and lost production.

C_{LP} = Cost of Lost Production due to Poor Efficiency of Low Cost Fans and Finned Tubes

Flaring of incompletely condensed product.
Premature finned tube degradation due to low cost, untested finning processes.

C_S = Savings with Regional Technical Centres

Regular on site testing, inspection, fan adjustments, bundle cleaning, resulting in a unit operation continuing at original design capabilities. A technical centre would provide opportunities for debottlenecking and performance improvement upgrades as process conditions change or simple adjustments that may be reducing plant overall throughput.

Life Cycle Comparison between Hudson and Low Cost Low Quality Manufacturer

Cost Item	Hudson Products Corporation	20 Year Straight Line Calculation	Hudson LCC	Low Cost Low Quality Manufacturer	Low Cost LCC
C_{ic} = Initial Cost per Cooler Bay (Base Case)			$200,000		$170,000
C_{be} = Bid Evaluation and Inspection Costs	Assume 1% due to history of quality and executrion		$2,000	3% due to unknown manufacturing procedures	$9,000
C_{inst} = Delivery and Installation Costs	Delivery at 1% for In Kingdom FOB point		$2,000	Deliver at 8% for out of Kingdom FOB point	$16,000
	Units are modularized, assume 4 men 4 hours		$800	Triple to assemble bundles to modules and supports	$2,400
C_e = Energy Cost	Base Case two 40HP motors loaded to 75% of capacity = 60 x .746 = 44.76 KW	44.76KW at $0.05/kwH and 8000 hours per year over 20 years	$358,080	Low cost fans typically are tested at 25% less efficient then purported on specification sheet	$447,600
C_{m} = Maintenance Cost	Hudson fan replacement	No fan replacement over equipment lifespan		Replacement once every 8 years with 2 hour equivalent loss of production	$303,200
	Hudson bearing replacement	Replacement once every 8 years with 2 hour equivalent loss of production	$151,400	Half of the Hudson Bearing Life	$302,800
C_{pe} = Cost of Poor Efficiency on Lost Production		None, units meet performance specifications		Loss of 0.01% equivalent production per day due to incomplete condensing resulting in flaring.	$1,277,500
C_s = Savings with Regional Technical Centres	Regular on site testing, inspection, fan adjustments, and bundle cleaning	Savings of 0.001% equivalent production per day with regular inspections.	-$127,750	No aftermarket or technical support for upgrading, trouble shooting.	$0
LCC = Total Life Cycle Cost			**$586,530**		**$2,528,500**

Assumptions:

Initial capital cost delta for low cost vendor = 15%

Plant Life = 20 years

Not adjusted for inflation

Labour rate for construction crews at $50 USD per hour.

Cost of Electricity = $0.05/kwH

Typical Operating Unit Producing 50,000 Barrels per Day of Oil Equivalent Loss of Production at $145,800 per hour.

Price per Barrel of Oil = $70 USD

Average Running Time per Year = 8000 hours

Fan cost = $5000 per unit plus $800 labour to install 4 men 4 hours

Bearing Cost = $2000 per unit plus $800 labour to install 2 men 8 hours to install.

Bundle Replacement Cost = $30,000 per unit