UNDERSTANDING THE BENEFITS OF **CLOSED-LOOP LIQUID COOLING OF INDUSTRIAL PROCESS & ELECTRONICS**

WITH MANUFACTURING SPACE AT A PREMIUM, MACHINE PACKAGES HAVE BECOME SMALLER AND LIQUID COOLING HAS EMERGED AS THE MOST EFFICIENT AND ECONOMICAL MEANS OF REMOVING PROCESS HEAT. LIQUID COOLING IS ESPECIALLY WELL ADAPTED TO HOT, DIRTY ENVIRONMENTS WHERE IT PROVIDES A METHOD OF REMOVING THE HEAT NOT ONLY FROM THE MACHINES, BUT ALSO FROM THE FACTORY ITSELF.

APPLICATIONS THAT CAN BENEFIT FROM WATER COOLING SOLUTIONS

AUTOMOTIVE
- SPINDLE MOTORS
- HYDRAULICS
- AUTOMATION DRIVES
- AUTOMATIC WELDERS

ENERGY
- SOLAR INVERTERS
- BOILER CONTROLS
- POWER PLANT ELECTRONICS

FOOD / BEVERAGE & PHARMACEUTICAL
- INGREDIENT MIXERS
- PRODUCT COOLING/DRYING
- PACKAGING AUTOMATION
- INSPECTION SYSTEMS
- OVEN CONTROLS

PAPER & PRINTING
- CHILL ROLLER COOLING
- INK COOLING
- CONVERTING MACHINES
- LAMP COOLING

WATER / WASTEWATER
- PUMP DRIVES

PLASTIC MANUFACTURING
- INJECTION MOLD COOLING
- EXTRUDER COOLING
- BLOW MOLD AIR COOLING
- MACHINE CONTROLS

COMMON DATA CONVERSIONS

1 TON	=	12,000 Btu/hr
1 BHP	=	2.545 Btu/hr
1 l/m	=	0.2642 gpm
1 kW	=	3,415 Btu/hr
1 kcal/h	=	4 Btu/hr
°F	=	1.8 °C + 32

HEAT LOAD — FLOW OF ANY MATERIAL: BTU/HR = MASS FLOW RATE (LB/HR) X SPECIFIC HEAT (BTU/LB °F) X TEMPERATURE DIFFERENCE (°F)

WHAT IS THE WATER SOURCE?

OPEN LOOP
ONCE-THROUGH
100% FRESH WATER
$$$$$$

VS.

CLOSED LOOP
RECIRCULATED
WATER
$$

EST. COST OF OPEN LOOP WATER

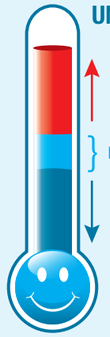
+ ≈ **$10.00** PER THOUSAND GALLONS

1/2 TON OF COOLING REQUIRES 576,000 GALLONS/YEAR

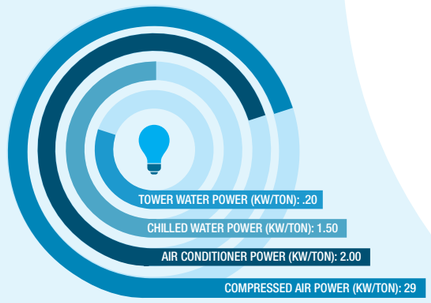
$5,760 PER YEAR

(BASED ON $10.00 PER THOUSAND GALLONS AND 3 SHIFTS PER DAY OPERATION)

UNDERSTANDING TEMPERATURE



EST. ENERGY COST OF COOLING



$ = TONS X KW/TON X HOURS X $/KWH

(FOR EXAMPLE, EST. ANNUAL COST OF COOLING FOR A 1/2 TON LOAD)

$

- COST OF COOLING WITH TOWER WATER: **0.5 X 0.2 KW X 8000 X $0.07/KWH = $56.00**
- COST OF COOLING WITH CHILLED WATER: **0.5 X 1.5 KW X 8000 X $0.07/KWH = $420.00**
- COST OF COOLING WITH AN AIR CONDITIONER: **0.5 X 2KW X 8000 X $0.07/KWH = $560.00**
- COST OF COOLING WITH COMPRESSED AIR: **0.5 X 29KW X 8000 X $0.07/KWH = $8120.00**

(BASED ON $0.07/KWH AND 3 SHIFTS PER DAY OPERATION)

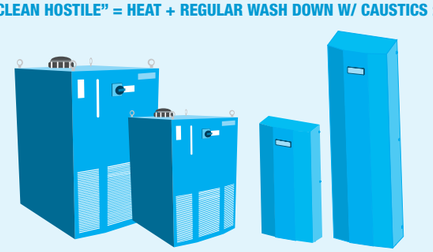
EQUIPMENT SELECTION & RECOMMENDATIONS

IT'S IMPORTANT TO NOTE THAT PROPERLY SELECTED EQUIPMENT IS THE KEY TO COOLING EFFICIENCY.

AIR CONDITIONERS: PROVIDE A CONVENIENT MEANS OF EFFICIENT COOLING FOR MANY INDUSTRIAL CONTROL COOLING APPLICATIONS.

WATER SOLUTIONS: OFTEN ARE THE ONLY METHOD OF PROVIDING SUSTAINABLE EFFICIENCY & RELIABLE PERFORMANCE IN "HOSTILE" ENVIRONMENTS.

< "DIRTY HOSTILE" = HEAT + AIRBORNE PARTICULATE &/OR OILS >
< "CLEAN HOSTILE" = HEAT + REGULAR WASH DOWN W/ CAUSTICS >



IMPROVE PERFORMANCE

ELIMINATE ELECTRONIC FAILURES AND INCREASE EQUIPMENT UPTIME WITH PFANNENBERG LIQUID COOLED SOLUTIONS.

REDUCE MAINTENANCE

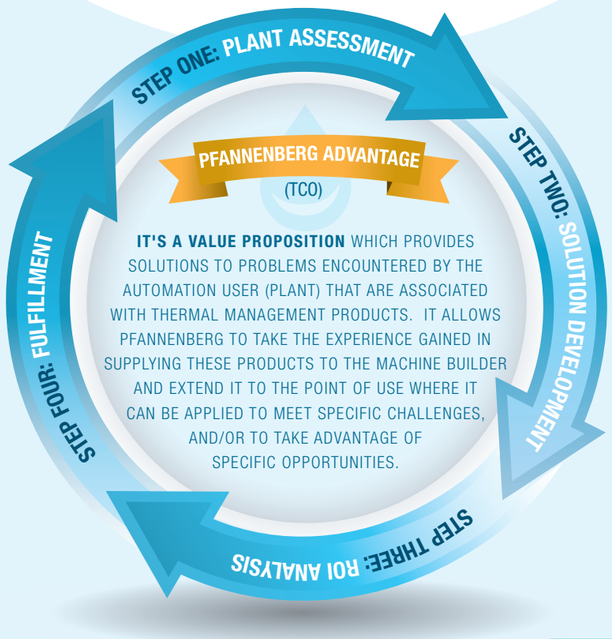
MAXIMIZE YOUR SYSTEM EFFICIENCIES WITH PFANNENBERG LIQUID COOLED SOLUTIONS.

EFFICIENCIES

TOTAL COST OF OWNERSHIP (TCO)

PREVENT UNPLANNED REPAIRS

REDUCE YOUR MAINTENANCE BUDGETS WITH PFANNENBERG PREVENT SERVICE PLANS.



IT'S A VALUE PROPOSITION WHICH PROVIDES SOLUTIONS TO PROBLEMS ENCOUNTERED BY THE AUTOMATION USER (PLANT) THAT ARE ASSOCIATED WITH THERMAL MANAGEMENT PRODUCTS. IT ALLOWS PFANNENBERG TO TAKE THE EXPERIENCE GAINED IN SUPPLYING THESE PRODUCTS TO THE MACHINE BUILDER AND EXTEND IT TO THE POINT OF USE WHERE IT CAN BE APPLIED TO MEET SPECIFIC CHALLENGES, AND/OR TO TAKE ADVANTAGE OF SPECIFIC OPPORTUNITIES.

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Pfannenberg
ELECTRO-TECHNOLOGY FOR INDUSTRY