# 3 Steps to Achieving High-Efficiency Chiller Performance

*New advancements and innovations make it possible for today's chiller technology to save companies as much as 60 percent on energy costs.*

## INTRODUCTION

In today's hyper-competitive market, manufacturers are constantly searching for innovative processes and new technologies that help minimize production costs to remain competitive and strengthen the bottom line. With low unemployment and rising labor costs, reducing energy expenditures is one area that can have a significant impact on the bottom line.

But it's not just about the bottom line either. Every company today is under pressure to join the corporate social responsibility (CSR) bandwagon and take measures to reduce energy use to help spare natural resources and reduce their environmental footprint. In recent years we have seen many improvements in both the production and sustainability fronts, with substantial energy efficiency gains in primary processing equipment, plant lighting, and auxiliary machinery.

For process cooling needs, many industrial operations use central chilled water systems. While there have been some improvements in energy efficiency, most manufacturers still work on the age-old principle of fixed-head condensing.

Surprisingly, many industries are unaware of new and pioneering advancements in cooling that can save individual operations as much as 60 percent in energy costs, while also helping companies establish a positive CSR reputation for going "green." Known as low-condensing or floating-head technology, these high-efficiency, cutting-edge chiller systems have undergone three progressive steps that make it possible to achieve unmatched efficiency in cooling processes.

## THE PROBLEM WITH FIXED-HEAD CHILLERS

Before diving into the three steps, it's important to understand the differences between the current process cooling technology many companies use to remove heat vs todays updated technology in advanced chillers.

Most chillers in use today use fixed-head technology. This equipment features refrigerant metered into the chiller's evaporator with a thermal expansion valve (TXV). Refrigeration works by warm water flowing through a chiller's evaporator that transfers that heat to the refrigerant and changes it from low-pressure liquid into a low-pressure gas. It is then converted into a high-pressure gas as it goes through the compressor.

From the compressor, it flows into the condenser, which can be either air- or water-cooled, and then condensed back into a liquid. It is here where the heat absorbed into the refrigerant is rejected. In a fixed-head system, the condensing temps are normally maintained at anywhere from around 105°F to 120°F, depending on the system. This temperature is maintained no matter what the load on the system or the ambient temperature of the air or condenser cooling water.

As you can imagine, fixed-head chillers using a TXV valve that keeps the temperature at a fixed point or range can consume electricity in huge amounts. This runs the compressors at full capacity, utilizing a hot gas bypass valve to control actual capacity needs. The way these chillers work has been compared to driving your car at full throttle and controlling your speed with the brake. This cooling approach can cause some pretty serious issues for any manufacturing operation:

- Higher energy costs
- Increased maintenance costs (due to higher stress on mechanical components)
- Shorter equipment lifespan

## UNDERSTANDING FLOATING-HEAD TECHNOLOGY

Over a multi-year period, engineers in the R&D department at AEC experimented with several different energy-saving technologies, including modifications to fixed-head technology. And, while energy efficiency could be realized trying to improve upon this conventional approach, they were not game-changing numbers.

The one area that held the most promise was floating-head technology. While this technology has been around for a long time, it was not very commercially viable until recently (as evidenced by the three steps we'll go through). To make this technology work properly, you need a highly orchestrated and accurate metering of the refrigerant that was not possible with older mechanical style TXV valves. Also, older programmable logic controller (PLC's) with slow processing power were incapable of doing the necessary thousands of calculations per second needed for real-time system adjustments.

So, how does floating-head technology work differently? We mentioned ambient temperature and load, and those are important factors. With floating-head technology, the condensing temps "float," as the name implies, based on the ambient cooling water or air temperature and load. In general, that can be anywhere from 10°F to 20°F above those ambient temperatures, down to the minimum saturated condensing temperature, which is approximately around 70°F.

Floating-head technology is in stark contrast to the fixed-head approach that keeps the chillers humming and draining energy no matter what the ambient temperature or load. These three steps demonstrate how a new approach – highly energy-efficient floating-head technology – is now viable and available today.

## STEP #1: ENERGY EFFICIENT COMPONENTS

As the AEC team continued to work on a new, more energy-efficient approach to process cooling, the first step that allowed them to make significant headway was the noticeable advancements in several key components used in chillers. These Include:

- Compressors
- Condensers and motors
- Valves
- Electronics
- Other components: displays, connectivity, "smart" technologies

Each of these components individually has made impressive strides in performance and energy efficiency. But, looked upon as a group and integrated to work together efficiently, the cumulative result is an ability to achieve superior cooling results. It's akin to how modern auto vehicles have progressed through the individual advancements of components like electronic stability control, LED headlamps, advanced driver safety systems, and autonomous technologies. These and other innovations, taken as a whole, have resulted in remarkable advancements in cars and trucks in just a few short years.

## STEP #2: ADVANCEMENTS IN KEY TECHNOLOGIES

In this step, AEC took a much closer look at some advancements with key technologies, specifically three areas:

- Condensers and motors - huge strides in energy efficiency
- Valves - more advanced electronic expansion valves
- Electronics - improved computing power

**Electronically-commutated (E.C.) motors on the condensers:** These are brushless motors utilizing permanent magnets on the rotors. They are also designed with built-in electronics to convert AC voltage to DC power and control voltage and power to the motor. The result is the ability to vary the speed of the motor. Extensive in-house testing by AEC showed this more advanced component was much more efficient than either staging or VFD fan motor technologies. EC brushless style motors are approximately 85 percent efficient, which is nearly 30 percent more energy-efficiency than a conventional AC motor.

**Electronic expansion valves (EEVs):** Historically, mechanical thermal expansion valves have been used in refrigeration. EEVs operate through thermal changes to the refrigerant in the sensing bulb of the expansion valve. Electronic expansion valves are an evolution to TXVs. It allows for pressure and temperature readings to be sent to a controller that can instantly adjust the valve based on operating conditions.

The benefits of EEVs include:

- Precise and accurate control
- Real-time, rapid responses to load changes
- Substantial energy savings

**Improved computing power in electronics:** To achieve much higher energy efficiency in chillers, improvements to controllers were needed to collect, analyze, compute, and control the entire system – in real-time. Like nearly every machine that relies on integrated computer chips or embedded software, greatly improved computing power enables tighter and faster control over the entire system.

Key performance areas positively impacted by today's computer power include:

- Proprietary algorithms and calculations
- Refrigerant, temperature and valve limitations
- Compressor envelopes
- Ambient operating conditions
- System controls

These newer controllers have upgraded electronics that allow for much more functionality and computing power, all at a fraction of the energy consumption.

## *Are you missing out on substantial energy savings from your ambient temperatures?*

Floating-head technology allows refrigerant pressures to “float up” or “float down” based on ambient temperatures. Condensing temperatures (head pressures) are maintained at 10˚F to 20˚F above ambient temperatures. So, as you can see from the visual below, the average ambient temperatures at your facility’s location can yield substantial savings, especially during the cooler fall, winter, and spring seasons.

## STEP #3: FLOATING HEAD PRESSURE

Ultimately, more energy-efficient components and advancements in key technology allow the effective use of floating-head pressure in industrial chillers. So how does this lead to lower energy costs?

In a standard R410A refrigerant system, the refrigerant pressure at a condensing temperature of 120°F is around 418 psi. This is where fixed head systems run 100% of the time regardless of ambient temperatures. If the condensing temperature was allowed to drop to 100°F, the refrigerant pressure requirement is now down to 318 psi. That’s essentially a 25 percent reduction in pressure that translates into much less stress and energy consumption. This is how floating head technology works, allowing condensing temperatures to float with changing ambient temperatures.

| Ambient Temp | Condensing Temp | Req. Refrig. Pressure |
|---|---|---|
| 100° F | 120° F | 418 psi |
| 80° F | 100° F | 318 psi |
| 60° F | 80° F | 233 psi |

In the evenings or overnight when ambient temperatures are lower – at 60°F ambient and 80°F condensing – the required pressure is now down to around 233 psi. That’s almost a 50 percent reduction in refrigerant pressure with even more energy savings. Companies with 24/7 operations taking advantage of these ambient temperatures will realize significant operating cost reductions. Bottom line, if your company isn’t taking advantage of ambient temperatures by using floating head pressure technology, you’re missing an opportunity for significant energy savings.

## Case Study Snapshot: Industrial Manufacturer

An Industrial Manufacturer looked to replace their 80-ton reciprocating compressor chilled water system with an energy-efficient solution. As a leading provider of innovative flow metering and control solutions for smart water management, buildings, and industrial processes, the environmentally focused company put a high priority on finding the most energy-efficient chillers.

With a groundbreaking AEC floating-head chiller system newly developed, the company agreed to a beta test installation.

The results were compelling:

- Originally estimated $12,000 in savings.
- Saved over $28,330 in the first year of operation
- Average savings of $2,361 per month
- Experiencing 70 percent energy cost savings

*Read the Case Study Here*

## CONCLUSION

The last decade has seen enormous improvements and progress in modern refrigeration and cooling systems, spurred by innovations in electronics, computing power, more efficient EC motors and fans, and other advancements. However, new technologies that can allow much higher energy efficiency with chillers for industrial process cooling have gone largely unnoticed or ignored by many manufacturers.

For companies in a variety of industries, chillers that leverage a newer – yet proven – floating-head approach can mean substantial energy savings of up to 60 percent. Rather than relying on outdated fixed-head chillers that always keep one foot on the accelerator and one on the brake, regardless of ambient temperature or load, forward-thinking and environmentally conscious companies now have a much better cooling option. Instead of running compressors at maximum capacity no matter what the outside variables, agile and responsive floating-head chillers can precisely match system capacity with demand and tailor operating performance to ambient temperature.

Based on the considerable research and beta testing from the AEC team, floating-head pressure technology can instantly transform your process cooling function, cutting your energy costs and helping to reduce your carbon footprint.

### *AEC can help save you up to 60 percent or more on energy costs*

The AEC High-efficiency Central Chiller is designed to meet the process cooling needs of the most agile manufacturing facility. The units are remarkably energy-efficient and can save up to 60 percent in electrical costs. The system continuously measures ambient and process conditions and will adjust to operate most efficiently. Designed with electrical, mechanical, and control redundancy, paired with predictive analysis, downtime is virtually eliminated.
These energy-efficient chillers offer several key advantages:

- **Save on energy costs** – up to 60 percent savings compared to traditional cooling solutions
- **Expand as needed** – modular design allows daisy-chaining of up to 10 modules for 600 tons of cooling capacity
- **Eliminate downtime** – if a unit goes down, others automatically compensate to maintain the needed process temperature

## ABOUT AEC

Established in 1957, Application Engineering Company is now known worldwide as AEC.

AEC is a market leader offering material handling, process cooling, temperature control and size reduction auxiliary equipment for the plastics industry and other manufacturers. Today, AEC continues to offer one of the broadest portfolios of packaged and central chillers, and has grown to be a leader in blending, drying, and conveying, serving a wide range of process industries.

AEC technical experts are dedicated to helping companies in a wide variety of industries find the right solution for their process needs.

For more information,
visit www.aecplastics.com
or call 262-641-8600

***High Efficiency Central Chillers***