HVAC Equipment Automated Diagnostics

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- 60% Commercial building floor space using RTUs
- 160 Trillion BTUs Annual cooling energy consumption
- 46% Not properly charged
- 64% Economizers need service

Large potential savings
Virtual Sensors

Some measurements are difficult or expensive: air flow rate, refrigerant flow rate, compressor power. Some are impossible: system charge.

Use low cost sensors with mathematical models instead to estimate these quantities.

- More information for FDD at lower cost
- Shorter payback period

Fault Detection

Combine engineering knowledge with statistical classification techniques to make robust tools.

Compare models of normal behavior with actual observations.

When our confidence exceeds a threshold, declare a fault.

Impact Evaluation

Methods to evaluate a faults’ impact on system performance are being developed, including:

- Capacity
- SHR
- Energy Consumption
- Efficiency
- Runtime
- Comfort
- Equipment Life
- Service Cost

Fault Diagnosis

Apply empirically validated gray-box models to isolate faults.

Focus on embedded diagnostics for widely used types of equipment. Laboratory tests and training offers several advantages:

- Experimentally trained models are more robust than field-trained models
- Smaller engineering cost because of narrower focus
**Virtual Sensors**

Experimentally validated virtual sensors

Accurate results even when other faults are present

**Fault Detection**

Developed AFDD software implemented in field installed equipment and have identified faults.

**Impact Evaluation**

Energy impact estimation has been applied to actual field installed equipment.

**Fault Diagnosis**

AFDD tool demonstrated to have accurate diagnosis performance for impactful faults.