Intelligent AHU

Retrofitting Legacy AHUs for Intelligent Air Handling

By Suresh Balakrishnan Co-Founder and Joint Managing Director, STULZ- CHSPL India Pvt. Ltd., Mumbai

Introduction

Today, with rising costs and limited availability of power and space, intelligent and efficient air handling has become essential. Comfort, health, productivity and greater energy efficiencies in large commercial buildings and facilities depend on their air handling capabilities. 'Intelligence' in Air Handling Units (AHUs) assumes even greater importance in critical manufacturing premises such as pharma and semi-conductors; large spaces with high footfall such as airports, five star hotels and malls; and all other buildings that need superior air quality management for critical hygiene such as hospitals and clean rooms.

However, shifting from manually controlled assembled legacy air handlers to high end digitally controlled AHUs with seamlessly working factory fitted parts may pose a business challenge from a capex perspective – especially when the legacy machines are yet to fully depreciate. Intelligent air handling retrofits address exactly this challenge. A customized solution to fully upgrade an existing AHU to an advanced BMS compatible AHU, with programmable controller and CO_2 sensors along with EC fans, reduces energy usage up to 60 percent. Retrofitting just EC fans into legacy systems, even without the controller and sensors, would result in up to 25 per cent improvement in energy efficiency. However, the full benefit of adding EC fans is derived only from fully digitizing the legacy AHU.

About the Author

Suresh Balakrishnan, co-founder and joint managing director of STULZ CHSPL India Pvt Ltd., is an HVAC industry business leader. Over the two decades under his leadership, STULZ grew to market leadership position in mission critical cooling solutions in India. The introduction of EC fan technology to HVAC industry in India by STULZ group in 2005 was under his leadership, and today this technology is widely accepted and used across HVAC applications in the country. STULZ has more recently expanded to industrial and commercial cooling applications with its i-AHU product range, which is an upgrade from the legacy systems currently in use. Suresh holds a Bachelor of Engineering degree in Production from Mumbai University.

The Solution

To understand how the solution delivers that level of performance, we need to understand the collaborative functioning of its constituent parts:

- BMS ready programmable intelligent controller with instrumentation
- EC fan motor technology
- VOC/CO_2 sensing with option to incorporate chemical media filtration

BMS Ready Programmable Intelligent Controller with Instrumentation

For Air Handling Unit retrofits, the greatest impact is from installing an Intelligent Controller for seamless operation of the AHUs. This enables not just more efficient fan usage, but also controls return and supply

Figure 1: Intelligent controller

air temperatures through chilled water valve modulation, and receives feedback on various parameters through instrumentation with the option to monitor with a remote PC or BMS. The Controller has optional CO_2 sensing for indoor air quality management, and options for auto operation control logic. It, therefore, requires insignificant manual intervention after being programmed. The smooth user interface and data availability on a touch screen make it easy to operate. Apart from significant Opex savings, a major advantage of installing the Intelligent Controller in an AHU retrofit is the flexibility and better response capabilities for the user to set key parameters. The user can easily set these key parameters to meet specific local requirements at the centralized BMS and/or AHU level operation, as required.

The Controller has information as well as configuration features, which continuously provide feedback on supply air temperature, return air temperature, fan power consumption (kW) and air volume (cfm) data. High energy efficiency is achieved by supply temperature data input controlling the chilled water valve and return air temperature data input regulating the fan speed from 0 to 100 percent. Return air temperature can also optionally control the existing 2 way, 3 way or pressure independent valve for modulation purposes, while the differential pressure switch installed in the duct controls the fan speed as required, based on pressure set points. All the intelligent controllers installed in the building can be looped and the Controller can be directly integrated with the BMS via Modbus RTU or BACnet protocol communication. The controller data can also be directly communicated to a standalone PC for centralized AHU control in the absence of a BMS. All data is recorded in graphical format on the touch screen as well as on the remote computer, as shown in *Table 1*.

Table 1: Illustration of parameters and control input

Return air temperature	Fan input
Supply air temperature	CHW valve input
Return air humidity	Duct pressure
Supply air humidity	CW in temperature
CW out temperature	Others

Typical Data Display

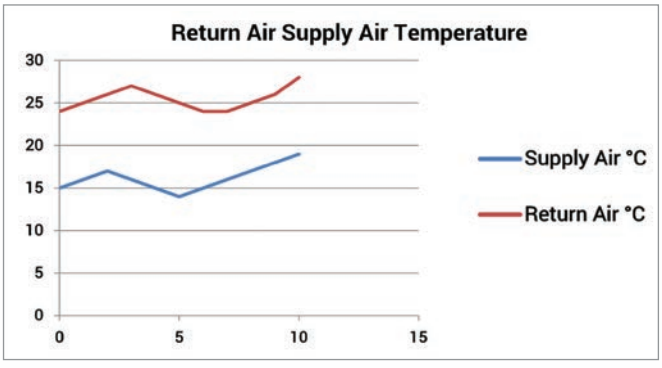

Figure 2: Return/supply air temperature graph

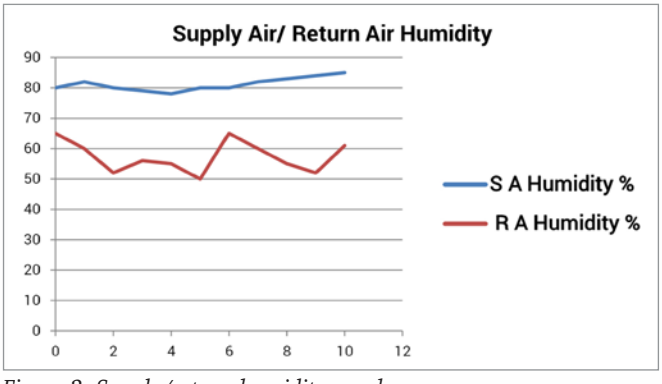

Figure 3: Supply/return humidity graph

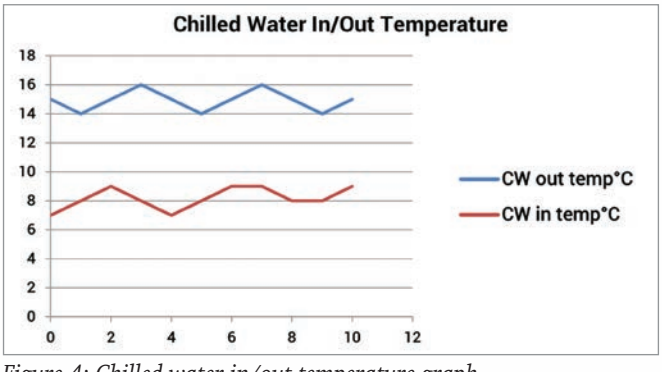

Figure 4: Chilled water in/out temperature graph

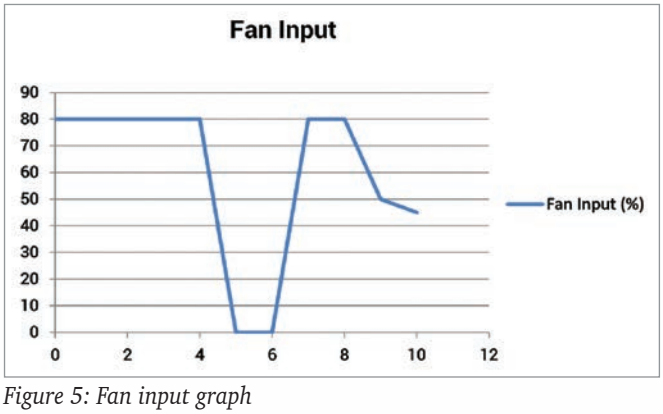

Figure 5: Fan input graph

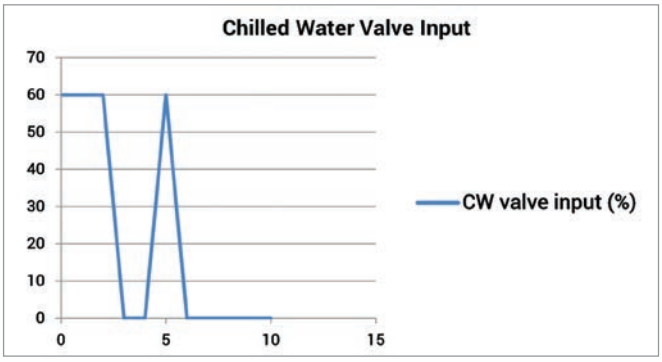

Figure 6: CW valve input graph

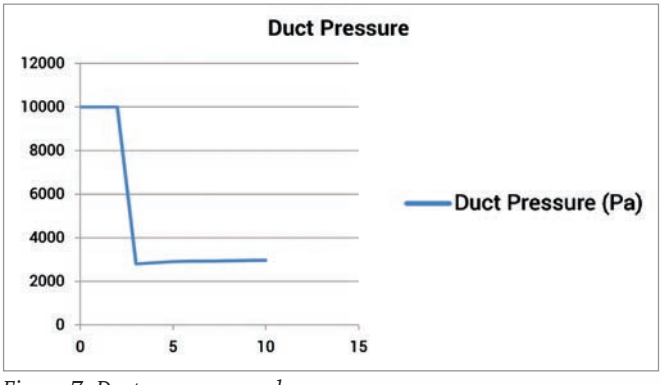

Figure 7: Duct pressure graph

EC Fan Motor Technology

The other important element in an AHU retrofit solution is the replacement of traditional forward/backward curved centrifugal fans having an AC motor with an EC fan-motor. EC stands for Electronically Commutated, which means it is a fan with a brushless DC motor. Basic DC motors rely on carbon brushes and a commutation ring to switch the current direction, and therefore the magnetic field polarity, in a rotating armature.

Figure 8: EC fan motor

Types of Motors and Efficiencies at 500 Watts

Shaded Pole Motors

- Motors with efficiencies between 20% and 30%.
- Motor is restricted to 30 W shaft power only. The other motors provide 500 W shaft power each.

Permanent Split Capacitor (PSC) Motor

- Motor with maximum efficiency between 60% and 70%.
- Requires external run capacitor.

Three Phase Induction Motor

- Motor efficiency of about 75% along with fan.
- Only capable of speed control with external variable frequency drive.

EC Motor

- Motor efficiency ranging between 80% and 90% (motor and electronics combined).
- Speed control and speed monitoring can be built into motor electronics.

EC External Rotor Motor

Integrated drive electronics capable of speed control and communication; high efficiency DC permanent magnet motor.

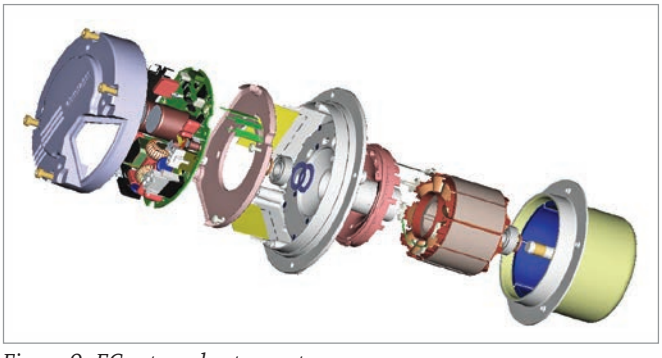

Figure 9: EC external rotor motor

EC Motors vs. AC Motors at Partial Load

- A major advantage of an EC motor is the use of speed control. The fan has an operating working range of about 10%-100% of the maximum speed.
- The power required by a fan has a cubic relationship to its speed.
- When using multiple fans in parallel, there are substantial energy savings in controlling the speed of fans down to reach lower cooling levels, than to turn a fan off.

Features of EC Motors

- Efficiency of motors is up to 90%, depending on selection.
- Variable speed, adjustable by analog and digital inputs.
- Mean time between failures of 80,000 hours ensures highest reliability.
- Optional temperature control, constant flow or pressure systems.
- Compact design, minimizing space usage.
- Eliminates need for external plenum at AHU outlet in specific applications.

VOC/CO_2 Sensing with Chemical Media Filtration Option

This retrofit is specially useful for treated fresh air units.

One of the biggest challenges faced today by high footfall, long working hour commercial buildings like hospitals, office

continued from page 34

buildings and hotels is to maintain a good level of indoor air quality while optimizing the additional air conditioning load resulting from inducing fresh air into the buildings. Apart from this, even fresh air brought into the buildings in metro cities very often contains high levels of pollutants, which further add to the deterioration of indoor air quality while adding load on the air conditioning system. This is a major contributor to sky-rocketing energy bills, with negligible positive results.

Improper ventilation design is known to account for as much as 60 per cent of indoor air quality (IAQ) issues. This, combined with inefficient temperature management and air handling – an inadequate exchange of treated fresh air in proportion to recirculated air – contributes to an increased risk of several building related symptoms and illnesses. Concerns about developing the 'sick building syndrome' are relatively recent. This poses significant challenges in fixing older building that were built before ASHRAE revised design specifications for ventilation around 2008. Tolerances were then increased to tackle the inherent problems of poor ventilation and high volatile organic compound readings indoors. Retrofitting with more 'intelligent' parts is a viable option in many cases to meet newer tolerance level specifications, especially in older buildings.

In legacy AHU systems, this important aspect of fresh air treatment and indoor air monitoring was done independently, as the need for instrumentation and controls did not make it possible to integrate air purification with the AHU. However, with the use of Intelligent Controllers during AHU retrofit, it is now possible also to integrate carbon dioxide and VOC sensing in the air stream of the AHU plant room and enable/ disable the intake of fresh air into the buildings. Further, if the

Figure 10: Chemical media filter for intelligent AHU retrofit

ambience in the building vicinity has a high level of pollution due to reclaimed land banks, sewerage lines, drainage lines, industrial surroundings, high traffic conditions, etc., the fresh air brought into the buildings would have high levels of pollutants. It, therefore, needs gas phase filtration treatment before it is infused into the indoor air stream, for better control of the VOC – CO_2 levels indoors. This is possible by integrating air purification via chemical media filters in the filter section design of the AHU, in addition to particulate filtration that would be already available in the unit. Based on the additional estimated pressure drops on account of the chemical media filter, the air purification system can be designed as a standalone module with its working controlled based on inputs from the intelligent controller so the entire system works as an integrated unit. Alternatively, in case of treated fresh air unit application, the EC fan for retrofit needs to be selected taking into account the additional pressure drop due to chemical media filters, which can vary from 100Pa to 400Pa.

A. Sample Illustration and Analysis of Intelligent Retrofit Solution

Audit		Design		Install		Maintain	
Operating Cost Savings							
				Legacy AHUs		Intelligent Retrofit (Controller + Sensors + EC Fan)	
Area	Level/ Floor	No. of AHUs	CFM	kW/AHU	Total Power	kW/AHU	Total Power
Lab	2	7	18000	8.75	61.25	6.45	45.15
Total (A)		**7**			**61.25**		**45.15**
Commercial	Ground	5	12000	5.2	26	4.3	21.5
	1	6	6000	2.6	15.6	2.15	12.9
	3	6	30000	15.05	90.3	10.75	64.5
Total (B)		**17**			**131.9**		**98.9**
Grand Total (A+B)		**24**			**193.15**		**144.05**
Total savings in power consumption with Intelligent Retrofit Solution (kW)							**49.1**
Lab Area: Annual savings in INR with Retrofit Solution				**(Assumed tariff @ Rs. 10 for 24 hour operations)**			**14,10,360**
Commercial Area: Annual savings in INR with Retrofit solution				**(Considering tariff @ Rs.10 for 12 hour operations)**			**14,45,400**
Total savings/year in INR							**28,55,760**
Total savings for 5 years in INR							**1,42,78,800**

B. Replacement of Legacy AHU with Intelligent AHU

				Legacy AHU Solution				Intelligent AHU Solution (Controller + Sensors + EC Fan)				
Area	Level/ Floor	No. of AHUs	CFM	Dimension (LxWxH)	BMS Control Type	kW/AHU	Total Power	Dimension (LxWxH)	BMS Control Type	Floor Space Savings (%)	kW/AHU	Total Power
Office Area	7	1	6000	2160 x 1950 x 1270	Controlled via BMS	2.32	2.32	2100 x 1350 x 1350	Local control with intelligent controller and instrumentation	33%	1.32	1.32
	8	1	12000	2500 x 1500 x 2200		7.5	7.5	2500 x 1970 x 1820		Designed to suit site conditions for lower noise	4.41	4.41
	7	1	6000	1970 x 1060 x 1680		2.3	2.3	2100 x 1350 x 1350			0.98	0.98
	8	1	3000	1430 x 1460 x 670		2.12	2.12	1150 x 1500 x 700			1.08	1.08
Total		**4**					**14.24**					**7.79**
Total savings in power consumption with Intelligent AHU solution (kW)									**6.45**			
Total savings in power consumption with Intelligent AHU solution (%)									**45%**			
Annual savings in INR with AHU solution (considering tariff @ Rs.10 and 24 hours operation)									**5,65,020**			
Total savings for 5 years in INR									**28,25,100**			

Conclusion

The key benefits of an intelligent AHU retrofit solution are:

1. Up to 60% higher energy efficiency by installing a BMS compatible, intelligent controller and instrumentation.
2. Up to 25% higher energy efficiency on retrofitting only EC fans.
3. Optimization of fresh air loads with real time VOC or CO_2 sensing.
4. Improvement in indoor air quality with added chemical media filters in addition to particulate filters.
5. Reduced maintenance and manpower cost.