FREQUENTLY ASKED QUESTIONS.

The following are frequently asked questions on induction systems. If you have a question that is not here, sorry, there are no prizes, but please call Dadanco and your question will be answered.

To assist you in finding an answer to your question, the FAQ's have been put into the following groupings:

1. Introduction to Dadanco STARLINE induction systems
2. Comparing Dadanco and other systems
3. Energy related issues
4. System design
5. Unit performance
6. Piping and insulation
7. Heating
8. Testing, commissioning and maintenance

To gain most benefit from the FAQ's, please take the time to read them all. This will give you a far better understanding of the Dadanco unit characteristics and performance. If your question isn't here, please contact us.

1. Introduction to Dadanco STARLINE induction systems

1.1 What is an induction system?

An induction system is an air-water system that uses the energy conveyed by two fluid streams to achieve the required cooling or heating in a space.

The air is called the primary air and is a constant volume variable temperature air flow, supplied under pressure to the plenum of the induction terminal unit where it is discharged through a series of nozzles. An area or zone of low pressure is thus created inducing return air through the secondary water coil into a mixing chamber in front of this coil,. This is known as the secondary air stream.

The coil is supplied with chilled water at a temperature to offset the internal loads of the space. The flow is known as the secondary water flow, from the early designs when the water was taken from the leaving side of the primary air handler cooling coil, and was therefore secondary water. The water from the building refrigeration plant that supplied the primary air unit coil was, and is, referred to as the primary (chilled) water.

The systems are ideal for handling the constantly varying perimeter loads. With the ability for unit-by-unit control if needed, the induction unit remains a viable answer for control in offices and open spaces of the perimeter zones. The principle of the induction unit has now been extended into the internal zones, with savings in space requirements and energy usage.

1.2 What are the alternatives Dadanco can offer to owners/managers/consultants of commercial buildings with existing induction units and associated air conditioning systems?

Dadanco have two distinct upgrade paths. Choose either Dadanco Refurbishment or Dadanco Retrofit. For many clients, this choice is made after Dadanco have carried out tests on air flow and noise on the existing to determine which is the most economical path to follow.

1.3 Does Dadanco have something to suit the make and model of induction unit currently installed in the building?

Yes. Dadanco has refurbishment and retrofit options for a wide range of existing induction units. The extent of refurbishment is best determined by tests on sample existing units at our Adelaide office. The written report provided on completion of the testing will describe what Dadanco recommend for your units.

1.4 What form of testing does Dadanco carry out on existing units?

Arrangements are made for some site tests on, preferably, two units, which are then disconnected and sent to Adelaide. One unit is tested as is for air flow and noise, providing benchmark data. Using these test results, modifications are made to the second unit, incorporating Dadanco STARLINE nozzles and air side flow path enhancement. The modified unit is then put through the same tests. Alterations are carried out to obtain the best performance result. The two units are then returned to your building and re-installed.

1.5 How can Dadanco help me reduce the total cost of ownership for a new building?

There are many elements in the “savings chain” where Dadanco can help you, including:

- Smaller ducting reduces ceiling space requirements for services
- Reduced ceiling height results in reduced building height or more floors of lettable space for the same overall height
- Smaller risers for ducts, giving more lettable area.

2. Comparing systems

2.1 Can you compare the “old” induction units with the Dadanco induction terminal units?

Yes. The major differences between the old and new units are that the new have:

a) Lower fan operating pressures, by a significant value.
b) Lower operating noise levels
c) Designs for in-ceiling units that allow maximum lettable floor area to the client are the norm.

2.2 How do you compare an induction system with an all-air system?

This question arises when a comparison of the cost to install and operate air conditioning systems is addressed at the design stage of a new project. The answer is that the comparison must be on a total system basis. This possibly sounds rather simplistic, but it is wrong to concentrate on one aspect of either system and make a comparison on that feature alone. For instance, the smaller ducts required in a Dadanco induction system is a reality, and a cost saving, but this does not mean the duct systems should be the only basis for comparison.

Both systems will have the same refrigeration or cooling capacity and, as a result, common refrigeration plant. The differences, and basis for comparison, are in the air handling and the plant and riser spaces that accommodate the air systems, as well as energy savings. A case can also be made for lower maintenance costs for the induction based system. While the air side is the obvious and major difference, there are also differences in the water systems, with water required to be distributed to the air-water induction terminal units.

Considering the air system as a whole, the Dadanco system has smaller air handling units, smaller risers, smaller ducts in the false ceilings and the potential for lower false ceiling heights. Economy cycles are applicable to induction systems. The advantage of a constant volume air supply to maintain air movement rates is an important element of indoor air quality considerations.

2.3 Are the pressure losses comparable in all-air and induction systems?

Yes. The pressure loss through the duct is what is important. It is therefore necessary to assess the two systems as complete installations, taking into account the AHU losses, filters, OA/RA path losses, the SA duct loss and then the VAV box and its duct and outlets or the induction terminal unit. No outlet loss is considered for the induction terminal unit as the pressure loss across it is supplied from the pressure at the nozzles. The losses between the VAV box, downstream duct and supply outlet will be very close to or higher than the induction terminal unit selected at 200Pa.

The VAV boxes vary in their pressure losses depending on the type of box and what added features it has such as noise attenuation and reheat banks. Some makes with these two features, and the downstream duct and outlets, have considerably higher losses than a terminal unit.

On the duct system, the route length will be very similar as will the Pa/m static loss. Therefore the total duct static loss will be similar for the VAV or terminal system. In a like manner, the losses across the cooling coil, filters and OA/RA system will be close to the same.

3. Energy related questions

3.1 When comparing the energy savings of an induction system with other systems, what items, in terms of energy usage, are not subject to the energy savings?

The chiller, cooling tower and the associated chilled and condenser water pumps. To these must be added the usual equipment such as the various exhaust fans, sump pumps, lift machine room systems and other building plant. The hours of operation are the same, as will be the energy cost, c/kWh.

3.2 When comparing the energy savings of an induction system with other systems, what items, in terms of energy usage, are subject to the energy savings?

The power used by the fans is the main difference, with the induction system primary air fan handling much less air, and therefore requiring less energy. If the system had a return air fan, the savings are improved, as this fan will also be smaller. As 3.1, the hours of operation are the same, as will be the energy cost, c/kWh.

4. System design

4.1 Can the existing duct and SCHW systems be reused in a retrofit project with Dadanco units replacing the original induction units?

Yes. The primary air flow will be the basis of the new selection for the Dadanco units. This means the duct velocities will remain the same, and hence the duct static pressure losses. The overall system static will reduce when the changeover is complete and no old units are operational and require the original higher pressure at their locations.

The secondary water flow will remain the same, although there have been proposals to increase it by 10% to cater for increased room loads. This decision is for the designer when deciding if the increase in pump power is acceptable in the overall energy equation. The range of coils available in the Dadanco units with the secondary air flow achieved with the new nozzles usually means a significant improvement in total unit capacity, with the original fluid flows and infrastructure.

4.2 Can the one primary air AHU feed all of the perimeter terminal induction units for a floor?

Yes. The correct selection of the primary air flow and temperature makes this possible. The disadvantages to the scheme are physical ones relating duct size, ceiling space, riser locations and the internal zone ducts and boxes.

The primary air is intended to handle the transmission load, treated as a steady state calculation, through the external walls. This is the same on all faces if the building construction is the same.

4.3 What is the effect of the fan motor heat on the primary air in a draw-through AHU?

The effect is to raise the temperature of the air leaving the air handler. The change can be represented on a psychrometric chart as a sensible heat increase, with the air leaving condition shifted to the right by whatever is the rise in dry bulb temperature. It can be thought of as reheat. This rise needs to be factored into the system design, as the primary air condition at the primary air plenum of the units must still be that used in the selection process.

4.4 How is condensation controlled in high humidity environments?

Outdoor air is pre-conditioned and dehumidified in the primary air handling unit, along with any return air needed to make up the primary air total. The building is maintained at a slight positive pressure with respect to the outside to control infiltration of humid air. Once the dehumidified air is in the space, the dew point is monitored and the secondary water temperature is controlled to remain above the dew point.

4.5 What about the system shutting down at night? Won't the humid air infiltrate and cause a condensation problem at start up?

The system can and should be shut down at night to save energy. This will cause minor infiltration of humid air and the humidity will increase. In Singapore for example, our experience indicates that the space humidity increase by as much as 10 – 15% over a weekend shut down. However, when the system is started up on Monday morning, the controls always calculate the dew point and maintain the secondary water temperature slightly above the dew point. During normal operations, this differential is always maintained with good controls.

This control of the secondary water can be incorporated with the optimum start program, to achieve savings over a conventional system. During start up with a conventional system, the air handlers are typically started and the chilled water valve goes wide open to provide maximum cooling.

With optimum start the first operation of the cooled and dehumidified air is to flush the moisture out of the space.

4.6 How do you maintain the secondary water temperature?

There are two methods:

1. By circulating primary chilled water through a plate heat exchanger with the secondary water passing through the other side. The secondary water pump circulates the full secondary water quantity through one side while a modulating valve controls the primary water flow to achieve the design secondary water temperature. A sensor in the outlet of the secondary water line controls the modulating valve.

2. The use of a mixing valve that allows an amount of primary water into the suction side of the secondary water circulating pump. There needs to be a connection back into the primary water loop to return a quantity of water equal to that introduced to maintain the secondary water temperature. A sensor on the leaving side of the secondary water pump controls the mixing valve.

4.7 Is the connection to the unit plenum always on the end?

No. The air connection into the plenum can be made into the centre of the side of the plenum. This is recommended where there is limited space between the units. It often eliminates a 90^o bend from the duct connection to the plenum, which will reduce the duct static pressure losses.

This is applicable to CM perimeter units, Active Chilled Beams and induction diffusers.

4.8 Can an induction system comply with the building regulations for smoke control with central plant installations?

Yes. AS1668.1-1991 nominates two methods for smoke control in buildings. These are purging and zone pressurisation, commonly referred to as sandwich pressurisation. Induction systems can perform in either design.

All central plant systems have fire dampers in the supply air ducts where they leave the riser and enter the floor, as well as a fire damper in the return air opening into the riser system. If these are not the motorised type capable of remote control, a separate motorised shut-off damper will be adjacent and in positions that do not compromise the operation of the fire dampers.

AS 1668.1 does not give a specific value for the supply or exhaust rates for either system Rather it describes the required method of operation to achieve the intended result of excluding smoke from all non-fire-affected compartments. It also deals with other possible building air handling systems such as car park exhaust, but this does not concern us here.

For the zone pressurisation option in a building with an induction system, the operation of the plant and dampers in the air systems is as the code. The fact that the total air moved is lower than for an all-air system is of no consequence. The induction system is capable of maintaining the minimum pressure difference of 20Pa between the fire and non-fire compartments. This pressure difference is tested with all doors closed to required exits. The maintenance of the pressure differential is a function of the exhaust rate from the fire floor and the pressurising air supply to the non-fire floors.

For the purging system, the requirement is for a balance between the supply of uncontaminated outdoor air and the smoke spill discharge rates.

For both smoke control methods the current design procedures will provide an installation complying with the regulations.

It is of interest to note that additional control strategies apply to VAV systems in AS1668.1. In the commentary in Appendix B for Section 5, Central Plant Systems, it is required that all boxes must fail open or be driven open in a fire emergency, to allow outdoor air to flow into the non-fire floors. This extends to the wiring of these controls in a fire rated power supply. There is an alternative, which is to provide a dedicated motorised bypass damper to allow the air into the non-fire floors. In a number of layouts this would place this inlet close to the return or exhaust point.

4.9 The major energy saving with induction systems is in fan power. What is the situation with pumping energy?

There is an increase in total pump energy as a result of the secondary water system. The primary water flow to air handlers is reduced, and the primary water pump energy is reduced accordingly. However, while the total pump energy for induction systems, primary and secondary, is higher than an all-air system, it does not significantly reduce the energy savings achieved with the fan power.

As with any exercise in comparing energy usage between competing systems, each installation must be looked at separately, and the savings of each assessed and considered against the other factors of cost, ongoing maintenance and ease of installation.

4.10 Can the fan power saving resulting from retrofitting with Dadanco products be calculated simply?

Yes**.** As the change is to an existing system, there is no change to fan type, ducts and other air-side characteristics, for which the formula for fan total efficiency can be used. This is;

$$\text{Total Efficiency \%} = \frac{q_V \times p_tF}{10\ P_R}$$

where q_V = volume flow of air, m^3/s

p_tF = fan total pressure, Pa

P_R = power absorbed by the fan, kW

The 10 is a constant in this formula. If the fan total pressures are the same, as is the fan efficiency, then the power absorbed by the fans is in the ratio of the two air flow rates.

The question can be answered best by giving an example from a project.

Example

The following is an example of how to calculate the reduction in fan power when Dadanco units replace old units that operated on higher plenum pressures.

Given: The induction units in an existing system required 380Pa (1.5"wg) primary air pressure at the nozzles. The replacement Dadanco units require 200Pa, a reduction of 180Pa. The original and design total pressure at the primary air fan was 1500Pa (6.0"wg). With the Dadanco units the total pressure reduces to 1320Pa. What is the saving in fan power?

Answer: From the fan laws, the relationship of the new total pressure to the old is given by:

$p_2 = p_1 \times (n_2 / n_1)^2 \times (d_2 / d_1)^2 \times (\rho_1 \times \rho_2)^1$, where

p = pressures, 1 original and 2 the revised values for p, n, d and ρ.

n = speed of the fan, r/s

d = fan diameter – which does no change and this element can be deleted

ρ = density of the air, which does not change and can also be deleted

Then
$p_2 = p_1 \times (n_2 / n_1)^2$, and p_2/p_1 is 0.88.

As n_2 / n_1 the square root of p_2/p_1, the ratio of the speeds is 0.9381.

If we now consider the law relating the change in power, P_R, it is similar to the pressure change equation, and can be reduced similarly to:

$P_{R2} = P_{R1} \times (n_2 / n_1)^3$

$P_{R2} = P_{R1} \times 0.9381^3$

$P_{R2} = 0.8255\ P_{R1}$

This represents a reduction of 17.45% in fan power.

The above presentation draws from the well presented Fan Laws page in the Fantech® catalogue.

Please note that it was the total fan pressure that was used.

4.12 What proportion of the load is handled by the primary air and what by the secondary coil?

If you are starting out on a design and need a feel for the division of the load between the primary air and the secondary water, allow for the primary air to handle the transmission load calculated as a steady state load. This is a quick and simple calculation using the design outdoor air less room air temperature, the areas of masonry and glazing and the respective U factors. The primary air will also handle the room latent load.

The secondary load is the sum of the people, lights, office equipment and solar load. The first three you will have based on normal design standards or the values in a brief, and the third by reference to solar load tables or your heat load calculation program.

Do not include the outdoor air load, as the primary air handler will handle this. If you use Camel, the program will include a part of the outdoor load equal to the bypass factor component. The "error" resulting from this is small and can be neglected. A word of caution though, don't let the bypass factor get stuck at 0.15. It will be much smaller for a larger or central plant unit and coil, and possibly lower for a packaged fan-coil unit. Check it out.

4.13 How many units can be controlled from one control valve?

Depending on the piping design and layout, several. A single control valve can control several units in the one zone, with a single temperature sensor controlling that valve. The piping and valves after the control valve should be such that the water flow to each unit is at the required design flow to each.

At the other end of the design scale, each unit can have its own control valve. It is not unusual for a pair of units on the perimeter next to one another to have a single control valve. They may even have their primary air supply from a single duct take-off.

4.14 How low can the secondary chilled water (SCHW) temperature be without causing condensation?

A basis for deciding on a secondary chilled water temperature is to relate it to the room dewpoint temperature. In theory, a surface at room dewpoint temperature has the potential to condense water vapour from the air. In still air conditions the air film on this surface will act as a layer of insulation, and allow the temperature of the surface to drop below the room dewpoint before condensation commences. The effectiveness of the air film depends on the velocity of the air over it. In still air conditions, the air film has the greatest insulating effect and could "increase" the surface to dewpoint temperature gap by around 1.5C. Therefore for a room dewpoint temperature of 13C, a minimum secondary water temperature would be 11.5C.

5 Unit performance

5.1 Can the terminal units be connected in series?

Yes. However the limiting factor is the velocity of the primary air, a function of the air quantity, entering the first plenum. Too high a velocity can generate unwanted noise. A practical limit is 9m/s. If design layout demands units be connected in series, contact Dadanco to discuss a larger spigot connection, and possibly a larger plenum.

5.2 Should the perimeter units blow at or away from the windows?

Experience has clearly shown that the correct method is to blow away from the window in Australian installations. If the application is for, say, North America and its colder regions, there is a practical requirement to blow a proportion of the supply air at the window in winter and the majority into the room, away from the window. This amount can still be directed at the window in summer or, if the outlet design allows, the air pattern can be adjusted to blow away from the window.

5.3 What is the clearance required for air entry to a CM coil, and lint screen access?

At least 300mm, set by the lint screen access requirement. From a need to allow adequate air entry to the coil, around 150mm would be sufficient.

5.4 Are induction units noisy?

No. The older installations used circular nozzles in a variety of sizes and configurations. The multi-lobed STARLINE nozzle developed by Dadanco is much quieter, partly as a result of the lower operating pressure it operates at. Noise data from tests is available on application to Dadanco, or reference to the Noise section of the Dadanco System Handbook.

6. Piping and insulation

6.1 What about the flexible hose to copper tube connection?

The flexible hose recommended by Dadanco is specially designed for this application. The hose consists of either a stainless steel hose or steel jacketed EPDM type hose with special push on connectors. The connectors contain dual Viton sleeve rings that expand under pressure of the system. In addition the fitting contains a "shark tooth" type of arrangement that grabs the copper tube. The more you try to force the connector off the tube, the more it digs in.

6.2 What if a pipe leaks?

Leaking pipes or fittings are not an issue. The seamless hard-drawn copper tubing of the secondary water system will have been tested to around 1500kPa as a part of the commissioning. The operating pressure at the coil in the unit is normally around 300 – 400kPa. Ask the question, "How often do sprinkler pipes leak?" It is rare.

6.3 Do you need to insulate the return water line in the false ceiling?

This depends on the temperature of the return secondary water. If the flow to the coils was at, say, 13C, the return could be 15 –16^{o}C. There is no danger of condensation and the pipe would gain heat from the ceiling if it were uninsulated. The ceiling would probably be a return air plenum in current designs, at about 25^{o}C. If the method to calculate heat gain to pipes given in the AIRAH Design Manual DA16 is followed. It will be seen that the gains are very small. The gain helps, in the system heat balance, to cool the return air.

This is a practice observed in many older installations. However they invariably insulated the piping in the riser to the plant room as the air was no longer effectively still air and the temperature could be several degrees above the plenum ceiling temperature.

If the pipe is to be insulated, remember the insulation is to reduce thermal gains and not prevent condensation. The costly vapour barrier is not required. It may mean a few more lines in the specification to include a thermal insulation for piping, but the cost saving to the client is worth it.

7. Heating

7.1 Can the Dadanco FM units be used for gravity heating?

Yes. Gravity heating is the name given to the heating achieved by circulating hot water through the unit coil at night and weekends, with the primary air system shut down. This is a common and standard design requirement in North America and Europe for induction terminal unit systems.

The terminal unit acts as a convective heater. Things to keep in mind are:

- Automatic control action at the induction units must be reversed, or bypassed, if heating is to be possible at night.
- The secondary water circuit should include a heat exchanger to warm the water when necessary.
- Tight shut-off valves must be used to prevent warm water entering the primary circuit at night.
- The heat in the secondary system must be dissipated in the morning the plant returns to normal weekly operation, before the refrigeration plant can be allowed to start chilling the primary water.

7.2 Is the gravity heating performance of the coil in the terminal unit affected by whether it is vertical or angled?

Yes, but not by much. For two units with identical coils operating under the same conditions, the unit with the angled coil will provide about 3% more heating output.

8 Testing, commissioning and maintenance.

8.1 How is the primary air flow measured?

The only way to accurately measure the primary air flow is by reading the static pressure in the primary air plenum. A test opening provided in the unit for this purpose. When this pressure is plotted on the primary air flow V's plenum static pressure chart provided with each project, the air flow can be read. Do not take readings in the duct near the unit and presume it will be the same in the plenum. It could be up to 80Pa out, or more.

8.2 Are inspections i.a.w. AS3666 necessary, and if so, at what frequency?

Yes, but only if the system creates condensate on the secondary coil. In this case, not usual for office building installations, the inspections would be the same as for any air handler with a condensing cooling coil. For the dry coil operation, the unit and drip tray should be inspected once a year for any foreign matter that might have found its way there.

8.3 How frequently do you need to clean lint screens?

Not very often. It is recommended that in the first year of operation, an inspection be made after three months operation. If clean, make it six months to the next inspection. Based on recent installations, yearly inspections should be adequate.

8.4 Can the capacity of a terminal unit be altered after installation?

No. At least, not easily if the intention is a change to the design total capacity of the unit. The load varies in normal operation by varying the secondary water flow. The primary air pressure and number of nozzles set the primary air quantity, a constant flow, with variations in air temperature to the outdoor air temperature schedule.

If the unit had small nozzles, these might be changed to the medium nozzles to increase the primary air figure. This should be referred to the Dadanco technical staff. There may have been additional holes provided for nozzles that were plugged at time of manufacture. This is not the normal case. If it were so, the plugs could be replaced with nozzles. This assumes the primary air system can supply the additional air.

The units are not intended for field alteration and any proposal to do so should be referred to Dadanco.

8.5 Can the handing of the secondary coil be changed in the field?

Yes. While the unit will be supplied with the coil orientation agreed prior to manufacture, the coil can be changed in the field. The coil is retained with brackets which can be removed, the coil rotated and the brackets replaced.

8.6 Will condensation occur if I have bad or poorly maintained controls?

It could. You should have them fixed! With the quality controls you have installed, the sensors will have detected the change in secondary water temperature and/or the high room dew point and will have initiated the pre-arranged controls program to raise an alarm with the maintainer; to reset the secondary water temperature upwards. As a last resort, the program will stop the secondary water pump until the fault is corrected.