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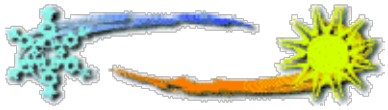
AIR CONDITIONING ON BOARD / 2



In this second part of the article, we explain the practical aspects of the installation, describing the installation on a 12m boat. This description can be used as a guide for any owner who wants to equip his boat with an air-conditioner, to produce cold air in summer and warm air in winter.

Picture 2: The three way splitter plenum is installed, following the procedure to preconnect insulated flexible ducts. A splitter plenum is a manifold chamber, preferably insulated, with one inlet and several outlets. A distribution plenum is a chamber used to connect a duct to a delivery grill.

After having explained the theoretical issue of onboard air-conditioning, we are now at the point to start a practical installation, putting theory on duty. We will start from the components needed for the installation, the heat load calculation and finally the detailed installation of each component.

Air distribution accessories

The air supply grill is the item which is clearly visible on an air-conditioning installation, but it is not the only one. The air-conditioner is usually supplied with a duct adaptor of a specified diameter suitable for the capacity determined by the air-conditioner. In order to connect the air outlet from the air-conditioner to the delivery air grill (see drawing) the following components are normally needed:

- flexible insulated duct
- duct adaptors
- splitter plenums (for installations with more than one grill)
- plenum chamber (to connect the duct and duct adaptor to the grill)

Picture 3: The space under the seat where the air-conditioner and most of the insulated ducts are to be installed. Ducts cannot be strangled or run in sharp bends as air needs to flow freely.

The only exceptions to this configuration are the direct expansion split units and the chilled water fan coils of boxed type for horizontal or vertical installation and direct air delivery, which do not need any accessory other than the intake and supply air grills.

Air filtration

The treated air should be preferably filtered to stop dust and other particles which can clog the finned air heat exchanger. Normally all the air handlers and boxed fan

Picture 4: The intake grill must have

coil are supplied with their air filter as a standard. or as an alternative the air filter can be installed on the air intake grill.

Heat load calculation

This is the name of the formula which is used to find the capacity needed to air-condition a room (cabin). The most simple formula needs the following data:

S=The floor area of the room to be conditioned (see drawing).

Te= External temperature

Ti= Desired Inside temperature

K=Thermal coefficient of the room to be conditioned (there must be a K, otherwise what formula is this?)

The formula is: Heat load = S x (Te-Ti) x K.

(Te - Ti) depends from the climate you want to consider: Mediterranean uses 8-10 which is the difference you want to achieve between outside and inside temperature. For tropical climates the standard used value is 15.

Finally we get to K: K value is determined by the solar gain, the quantity of people and the use of the room.

In a very rough calculation these are the values:

Owners cabin and guest cabins: K = 20-22

Saloon or dinette without or limited window and glass area (sail yacht or power "open" configuration): K= 28-30

Saloon or dinette with large glass area (power boat- Fly configuration): K=35

Wheelhouse (power boat) with very large glass area: K=40

For example, suppose you have to air-condition a dinette in a "open" power boat: its area is (3 x 2) = 6 sqM; the heat load is then:

Heat Load = 6sqM. x 30 (K) x 10 (Te-Ti)= 1,800 W/h.

This is a nice number which corresponds to the heat load to be extracted by the air-conditioner in order to keep the inside temperature 10 °C below the outside a sufficient area, enough to feed air to the air-conditioner. The intake of the air- conditioner doesn't need to be oriented toward the intake, as the fan can take the air from the entire space around it, but there must be enough clearance around the air-conditioner to permit air to flow freely.

Picture 5: As explained in the text, round closable grills are simply installed by making a hole in the wall. On the opposite side of the wall it is installed a distribution plenum connected to the air duct.

Picture 6: The air is ducted, through a connecting plenum to the owner's cabin and to the dinette; the grill for the owner's cabin is just above the locker door. You must remember that cold air falls and must be delivered at high level.

Picture 7: Above figure shows the delivery grill for the dinette, installed in the forward bulkhead; especially for the "day area" zones it is

temperature which is a Mediterranean condition, all expressed in W/h Most of the air-conditioners are given with a Btu/h capacity; the rate between W/h and Btu/h is 3.4, therefore our magic number is now 1,800 x 3.4 which is 6,120 Btu/h.

Contemporary loads

Contemporary means that the cabins of the "night" area and the rooms of the "day" area must be air-conditioned at the same time. This normally is not requested; the heat load calculation considers the maximum load for each room; in the day area it means that it is lunch time and everybody is at table, the cook is cooking and the sun is at its height. For the cabins the peak is reached in the first hours of the night when there is still the heat of the day, and two people are in the cabin. As you consider this situation, then you have to make the choice if you want the 'night' area air-conditioned at the same time as the 'day' area. This would mean that more capacity of air-conditioning has to be installed.

Practical example

We have choosen a power boat "open" type (no flybridge) 12 M. long. The plan of the boat (see drawing) shows a dinette with a galley, one aft guest cabin connected to the dinette and a forward owner's cabin.

The heat load is the following:

Dinette: 6(S) x 30(K) x 10 (Te-Ti) x 3.4 (rate w/h-Btus/h) = 6,120 Btus/h

Owner's cabin: 4.5 (S) x 22 (K) x 10 (Te-Ti) x 3.4 = 3,336 Btus/h

Guest cabin : 4 (S) x 22 (K) x 10 (Te-Ti) x 3.4 = 2,992 Btus/h

Total heat load = 12,478 Btus/h

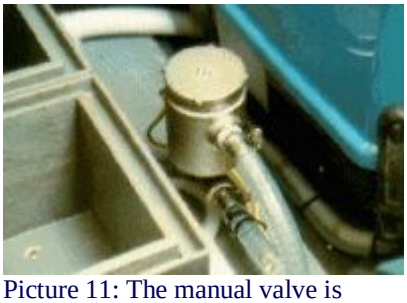
For the complete air-conditioning of this boat we need 12,478 Btus/h. If the boat is equipped with a small diesel generator of 3.5 KW, we must check that the air-conditioner will work properly with the available power source. We have calculated the total load but it is necessary to consider the "life" onboard. We can split the boat into two areas, as we have already said, "day" area and "night" area. The total load is a straight addition but the air-conditioning will be requested by only one area per time. From this consideration we can choose a unit capable of air-conditioning t he dinette important that air is supplied at deck head level.

Picture 8: The picture shows the components of the sea water circuit: A through hull "scoop" type intake, a manual valve, a centrifugal pump, different diameters hoses, and jubilee clips of different sizes.

Picture 9: The picture above shows the sea water pump installed on rubber antivibration mounts. The sea water pump must be installed at least 50 cm. under the water line. The skin fitting must be installed well under the water line with the boat in dry dock.

Picture 10: The through hull intake installed in the aft section. The scoop type intake oriented forward helps the flow and will clear the sea water circuit of air if it gets into the circuit. If installed facing aft it will prevent a proper functioning of the pump as the circuit will be emptied while cruising.

during the day in the hottest hours, reducing or isolating the cabin supply, which will need air-conditioning only in the night, when the heat load of the dinette is much less. This consideration is more valid for small and medium boats, as the air-conditioning of the main area affects all of the cabins. In this case the most practical, economical but not less effective solution is to install an independent air-conditioner in the dinette under the sofa and make three air outlets: one main grill for the dinette and two smaller closable grills for the cabins. As an alternative: 1 air-conditioner of 9,000 Btus/h for the dinette and the guest cabin, plus another air-conditioner of 5,000 Btus/h for the owner's cabin. This alternative is sometimes the only possibility as not always is possible to run a duct for the air distribution to the forward cabin from the dinette; the second unit has however the advantage to have an independent temperature regulation and also to have two independent and smaller units which will start in sequence and reduce the start current load on the generator. In facts the start current of two independent air-conditioners is always lower than the start current of one only air-conditioner with the same capacity.



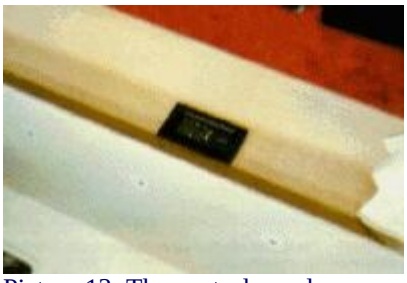
Picture 11: The manual valve is installed directly on the through hull intake; the sea water strainer is installed immediately after.

Third alternative: central system with a small chiller unit (12,000 Btu/h) installed in the engine room connected to a 9,000 Btu/h fan coil installed in the dinette and a second fan coil of 4,500 Btu/h installed in the owner's cabin. As to the configuration of the second alternative, the fan coil installed in the dinette is also cooling the guest cabin where the temperature is adjusted by means of a closable grill. This last solution is more expensive but also more complete and flexible as a third fan coil for the guest cabin can be added reaching a complete automatic control on all the cabins. Each cabin can have therefore its independent automatic temperature control not only on the fan speed as in the other solutions.

Picture 12: The space under the seat (sofa) is where the unit will be installed. In this space we install the two sea water hoses (in and out) and the electrical connecting cables. The sea water out through hull fitting must be drilled as low as possible on the water line in order to reduce to a minimum any noise from the falling water. (see drawing 6)

Installation

For the installation on this power boat of 12 M. we have chosen an air-conditioner manufactured by Veco of Giussano (Italy), Company well known not only in Europe but almost world wide. Veco has reached the ISO 9002 certification of its quality control in 1996. The drawing 2 of the air distribution schematic shows the position of the Compact air-conditioner, installed under the settee of the dinette; the air intake grill will be positioned on the vertical side of the seat; the air delivery is made connecting a flexible duct between the air outlet of the air-conditioner and a splitter triangular three ways plenum (B); from the splitter plenum there are two more ducts: one forward to the owner's cabin and one aft to reach the guest cabin. The most



Picture 13: The control panel position must be chosen considering an easy use and also the inside decor. The connecting cable is 3m long.

important leg is the forward one which will bring air to the dinette and the forward cabin. For the distribution to the cabin and the dinette, a plenum chamber is made on the top of the forward cabin locker, where two outlets are cut, one to the dinette and one to the cabin, where the dinette has priority.(drawing 5). In the drawings 3 and 4 it is shown the sea water circuit schematic with the sea water pump in the engine room and the piping to the unit and out.and also the electrical schematic with the remote control panel. As the flexible insulated ducts must bring different quantities of air, different diameters must be used in order to avoid high pressure drops and also to balance the air distribution. So the duct from the fan outlet to the splitter plenum is 125mm., from the splitter to the aft cabin is 75mm. and from the splitter to the fwd cabin and dinette is 100 mm. It is important to insist that the efficiency of the unit and a good air-conditioning plant are properly linked to a good air distribution layout. With a well detailed project, we will know what is needed, the length and diameter of the ducts, the position of the grills, and also choose the correct and better design as grills are available in different sizes and materials. When we say "grill" it means a specific type made for air distribution and not other types of grills such as used for air vents. The design and orientation of the grill fins are essential for a good air distribution. The first step is to determine the location of each component of the system, checking all the possibilities and watching that each component is accessible for maintenance, taking into consideration the manufacturer's specifications on service. The second step is to mark the position of all the holes for the passage of flexible ducts and the grill openings. Once the fan outlet position has been determined, and before installing the air-conditioner, we can drill the holes and install the flexible duct in the compartment next to the unit location; where we also install the 3 way splitter plenum connecting the duct as shown in picture 2. The intake grill (picture 4) is located in the vertical wall in front of the unit. In our case the air-conditioner intake is facing the intake grill, but this is not important once there is enough space around the air-conditioner and the intake air can run around it from the intake grill to the air-conditioner intake. In the aft cabin, we run a duct of 75 mm inside diameter, after making the hole in the bulkhead between the dinette and the aft cabin. We make two holes for the two round adjustable outlets (picture 5) which we install on the back of the bulkhead which is accessible, the distribution plenum is already connected to the duct by means of a duct adaptor of the correct size. In areas with reduced accessibility this sequence is the rule (connect first the duct to the plenum and then install the plenum) and so we are sure that the duct is well fitted on to the duct adaptor. The duct is fixed on

Picture 14: The air-conditioner Veco Climma Compact 12 RC comes on a wooden base for transportation and protection. Air-conditioners are not light weight!

Picture 15: A moment of the installation, when the fan scroll is oriented downwards to fit into the restricted space. A few screws are enough to make the change.

Picture 16: The air filter taken out from its plastic bag is installed in the front of the air-conditioner after the thermostat bulb has been fixed on its support. The thermostat senses the ambient temperature more effectively if its sensing bulb is installed in the return air.

the adaptor by means of screws, glue and/or silicon. It might be difficult to fit the duct to its adaptor as the two measurements are very close in order to ensure a good air seal. From the first splitter plenum (picture 3) we have the duct to the aft cabin and the other duct (10 cm. dia) which passes through the forward bulkhead between the dinette and the forward cabin and enters the locker. In this locker we have installed a panel in the top so as to make a custom distribution plenum (drawing 5) which feeds the air to the dinette and to the forward cabin. The distribution is made by means of a smaller grill (picture 6) above the locker door for the cabin and a main grill (picture 7) in the forward bulkhead. This solution is very practical and saves a lot of space. The possibility of simultaneously occurring loads is very rare, and we have considered using a manual valve (details in picture 5) which permits to close the grill of the cabin and concentrates the air-conditioning in the dinette during the day. This device must be studied and adapted to the boat configuration but it is practical and inexpensive solution when more cabins are conditioned by the same unit if the shape or size of a closable grill available in the market doesn't fit to our need.

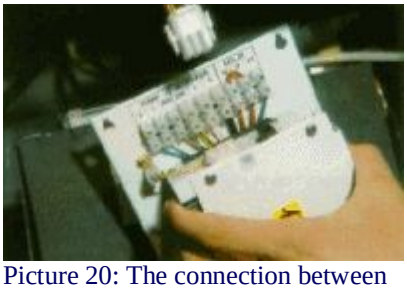
Picture 17: The bulb is installed on its support in the air intake section of the air-conditioner.

Picture 18: The air-conditioner is installed in its space and fastened by means of four practical brackets in stainless steel.

Sea water circuit

As the air distribution circuit is finished we have now to install the sea water cooling circuit (drawing 4). We need a scoop type intake port, a manual valve, a strainer, a centrifugal pump, a discharge port and suitable hoses (picture 8). The centrifugal pump, supplied with the air-conditioner is equipped with a stainless steel base with rubber vibration mounts (picture 9); the pump must be installed at least 50 cm. below the water line. The intake through hull fitting must be positioned possibly in the aft part of the boat. This job needs the boat to be in dry dock. Make sure to check the position both outside and inside the boat. The skin fitting must be accessible from inside, as the manual valve is installed directly on the intake port. The hole is easily drilled by a normal drill equipped by a special tool (centre bit) of the correct diameter. Make sure that the hole corresponds to the through hull fitting as it is quite difficult to increase the diameter of an already drilled hole. The scoop type fitting must be installed with the finned part (intake) towards the front, so that the speed will help the flow and will drain the air out . There is no risk in having a water circulation when cruising as the water circuit is closed and will discharge outboard, but the positive pressure at the intake will bleed air out of the circuit if the intake takes air in high speed. Air locking in the circuit is the most common cause of pump problems as the centrifugal pump is not self bleeding. A wrong installation (facing

Picture 19: The in and out hoses are then connected to the air-conditioner, taking care to respect the indications of the water flow direction. Great care must be taken in installing the Jubilee clips.



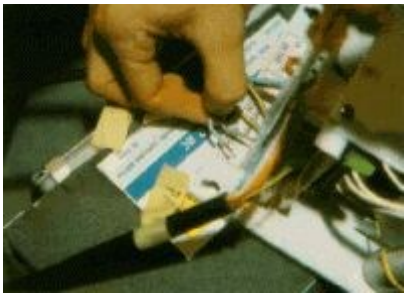
Picture 20: The connection between

astern) will prevent the water circulation even at low speed and worsen the air lock. Install the through hull in the keel using the appropriate sealant (silicon or equivalent) and screw it tight by means of the washer and nut; from the inside then install the manual valve and its hose fitting. From the valve to the strainer use a flexible hose I.D. 25 mm. as short as possible and the same size from the strainer to the pump intake (in the centre of the pump body). The intake leg from the through hull to the pump must be as short as possible. For the outlet from the pump you can use a hose 16 I.D. straight to the air-conditioner and then from the air-conditioner overboard. It is important that the first 50 cm of the pump outlet is orientated upwards so that any air entering the pump will have room to get out, leaving the pump full of water. The water outlet must be above the water line but not high (5-10 cm. are fine) so that it will be possible to check the water flow and also not so high that will sink your or somebody's else tender. All the hoses must be fastened using stainless steel clamps. The drawing 6 shows the characteristics of the ideal sea water circuit. In order to avoid syphoning and give a good and even flow, try to keep all the hoses as straight as possible and fix all the hoses to the walls and bulkheads.

Electrical circuit

It is mandatory to obey all of the safety rules and follow with extreme care the manufacturer's instructions and specifications (by the way, clear and very easy schematics). The electrical circuit includes the connections of sea water pump control panel mains supply (see drawing 4 and electrical schematic 7) Having cut a hole to the dimensions of the remote control panel on the wall above the seat where the air-conditioner is installed, insert the cable and the thermostat bulb and capillary pipe, and then fasten the panel (picture 13). The cable and thermostat bulb must reach the space where the air-conditioner is installed, where we will run also the pump and mains supply cables. The Veco air-conditioner model Compact 12 RC (picture 14) is supplied on a wooden base for a better protection during transportation, fixed by means of four stainless steel brackets to be used to fasten it at final installation. In order to meet any configuration the fan scroll can rotate from a upper discharge to a low discharge position, by just undoing a few screws (picture 15). Remove the plastic cover from the air filter: Before placing the air-filter in position (picture 16) install the thermostat sensor on its bracket in front of the air intake (picture 17). The air-conditioner is placed in its place under the seat and fastened using the brackets supplied with it and self tapping screws (picture 18). Then the water hoses are connected, taking

control panel and electrical box. The cable ends with a polarized plug: no hassles, but keep it dry!



Picture 21: Mains cable and pump cable must be connected to the electrical box. Make sure that each wires goes into its terminal and that the fixing screw block the copper wire correctly.

Condensate drain

Bear in mind that the air-conditioner, in high humidity conditions can produce more than 1 litre of water per hour. For this reason the air-conditioner is equipped with a condensate pan (picture 15) which has two discharge ports for connection to the bilge (picture 3) or, better, to a small tank with an independent drain pump. special pumps for lifting condensate are also available. If the bilge solution is chosen, make sure that the limbers are open and clean to enable the water to reach the bilge pump. If the independent tank solution is chosen, then we suggest a small tank with an automatic drain pump. The installation is now completed: just open the sea cock and check that the sea water circuit is tight. Then power the A.C. circuit and turn the new "Air.conditioning" circuit breaker to "ON "position. The system is ready to run. First push the "Cool" button on the remote control panel, then turn

care of in and out sense; picture 19 shows the fastening of the water hose on the top (out) connection using a stainless steel jubilee clamp; a very useful system is to mark each tail of hose and cable with masking paper tape, making it possible to write indications and marks. Then we connect the panel cable to the electrical box: there is no way to make a mistake as the cable terminal is a polarized plug. The sea water pump and mains wires have their terminals in the electrical box (picture 21).

the thermostat knob to the maximum heat (the compressor will not start) so you have the time to check the sea water flow. As you push the button, the pump and the fan must start. As you are happy with the sea water flow and the air flow, you can finally turn the thermostat knob counter-clockwise to adjust to mid range. The compressor will start, the air will become cooler. Enjoy your new air-conditioner. One only recommendation: do not regret too much of not having installed it before.

Previous part of this article...

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