Preface

I feel so small, so small, and I want to do something beneficial to society as much as possible. Thank God, i have finally successfully developed this free high-precision psychrometric chart software that implements two modes (horizontal and vertical setting modes for dry bulb temperature axis), hoping it will be helpful to you.

Full software name: HVACOL Psychrometric Chart Software abbreviation: hvacolPC

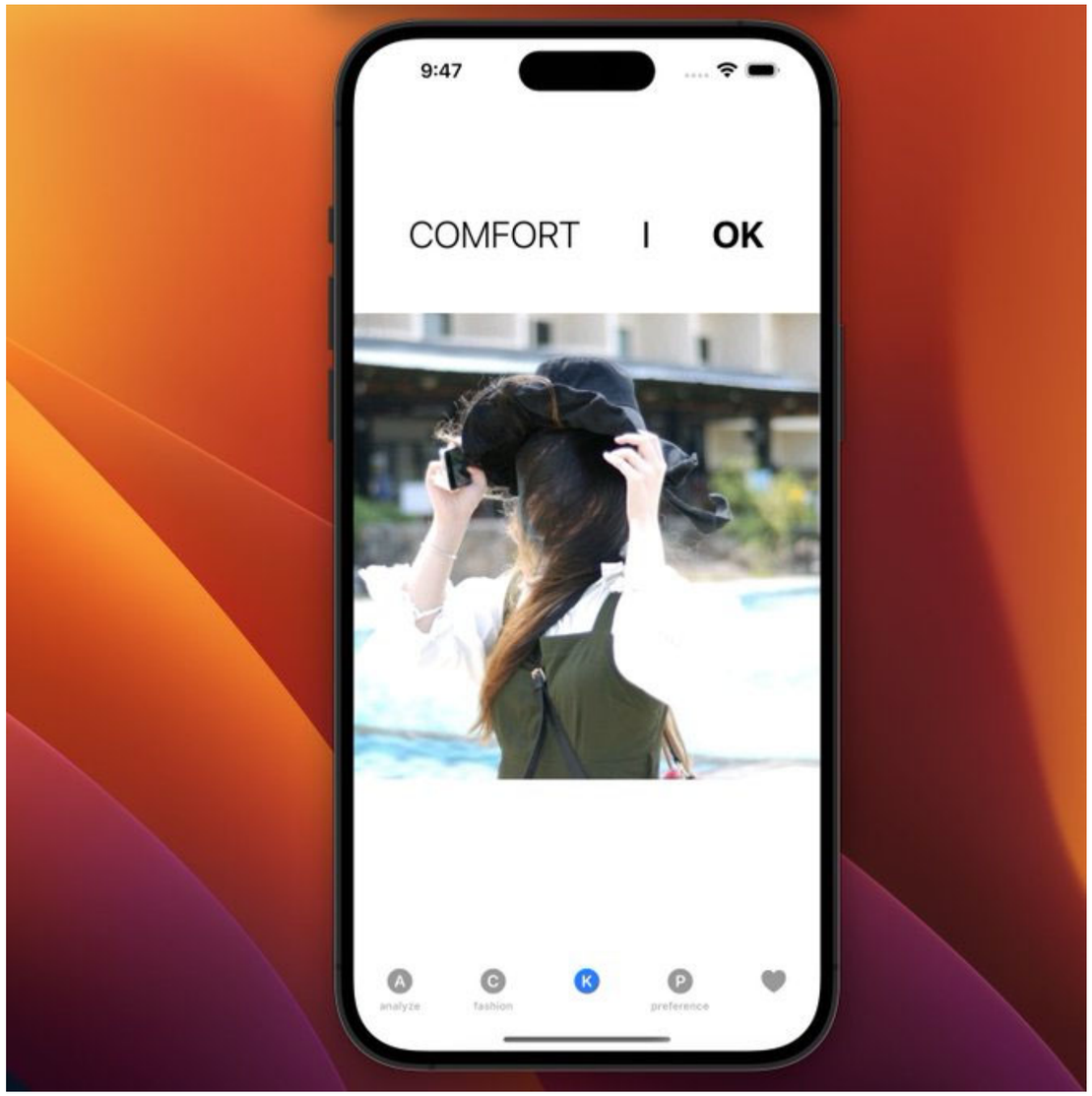
1. All features, completely and permanently free: generate all characteristic lines (drawn by values or through points), generate psychrometric chart in AutoCAD DWG document format, which is equivalent to source code: can fully control all the details of moisture air - construction industry, scientific research institutions, academic institutions, etc. Who doesn't use AutoCAD? AutoCAD is similar to OS design. With the psychrometric chart in DWG document format (equivalent to source code), you can do anything, anything.

2. Copyright Statement: Software Author Kelvin.Wang authorized user: Use this software and the final result document without the need to contact the author for authorization; The high-precision psychrometric chart design results produced by this software can be used for all commercial and non-commercial purposes without any cost (All copyrights of hvacolPC belong to Kelvin. Wang), and the software author does not assume any responsibility. You can use hvacolPC for work, design, learning, teaching, research, paper creation, presentation slides, and other purposes other than reverse engineering. You can also freely distribute the complete hvacolPC software package, but you are not allowed to make any form of modification or renaming to the hvacolPC program, interface and user manual, author copyright statement, logo style, etc. hvacolPC can coexist with any other auxiliary design system in the AutoCAD environment, but it must not be packaged into other software as part of other software. When using partial screenshots, it is not necessary to retain the logo of hvacolPC, but it should be mentioned in a certain part of the document that the psychrometric chart screenshot used was generated by HVACOL Psychrometric Chart.
Why is there such persistence? Please refer to the link: http://hvacol.com/forum.php?mod=viewthread&tid=1227

3. HvacolPC lifecycle

Due to backward compatibility with AutoCAD, generally speaking, hvacolPC can run continuously on all versions of AutoCAD 2012 and later (the Apple computer version will be provided in the future, please follow X.com/hvacol and Facebook.com/100011678140188 and hvacol.com for timely information). Starting from 2023, the author plans to personally maintain hvacolPC for at least 20~30 years. Simultaneously provide DWG, PDF, and large-sized Image image versions. These document formats are de facto industry document standards that can be maintained consistently in a computer information system environment. Generally speaking, you can use hvacolPC for a lifetime.

Currently, an app has been launched in the Appstore, which is used to calculate the comfort level of people wearing different clothing combinations in different temperature and humidity environments (PMV, PPD calculation). The name in the AppStore is: OiK



The OiK cover photo was personally taken by Kelvin.Wang in Indonesia, and the beautiful girl is a fashion designer.

For example, with a professional camera, users need to master professional photography skills such as setting aperture size, shutter speed, metering mode, exposure compensation, etc. The most important thing is to discover beautiful eyes and quickly capture beautiful moments with the camera.

Using hvacolPC for psychrometric chart calculation and analysis only requires setting parameters, making it easy and simple. Having a fully functional psychrometric chart software is like having a professional camera. As long as you are an HVAC professional, you will have everything you need (additional apps, like the camera's additional Auto mode, can more easily accomplish common purposes).

The upgraded version of OiK will add icons for different clothing combinations using AI generated models, which will be more intuitive with textual descriptions (currently the upgraded version is not available).

This handbook takes a primary return air conditioning system as an example to draw its summer moist air handling process on the psychrometric chart, quickly mastering hvacolPC

In the process of creating another HVAC professional PDF e-book, taking the most common household air conditioner in air conditioning engineering as an example, analyze the moist air handling process of household air conditioning systems on the psychrometric chart. Analysis of the most common household air conditioning system air handling on psychrometric charts? Have you never seen it before? The core knowledge of air conditioning is already hidden in the most common household air conditioning systems, while other types of air conditioning systems only have different forms of air conditioning due to different requirements. Office building air conditioning systems, industrial high-precision air conditioning systems (such as those used in chip workshops), pharmaceutical clean air conditioning systems, etc., are essentially the same as the most common household air conditioning systems, and explore why this form of air conditioning is used. So far, I personally haven't seen anyone talk about the process of air conditioning from the most common perspective of household air conditioning. There is also the addition of refrigerant to the evaporator of household air conditioners during maintenance, and the determination of its gauge pressure.

Centralized air conditioning system, where air handling equipment is centralized in the air conditioning room; A portion of the air handling equipment in a semi centralized air conditioning system is concentrated in the air conditioning room to process some of the air (while another portion of the air handling equipment is dispersed in various air-conditioned rooms).

The cold and heat sources of centralized and semi centralized air conditioning systems are generally centralized: the capillaries of dispersed air conditioning are integrated into a refrigeration station to become a large evaporator for one or several chillers, and many small condensers of dispersed air conditioning are integrated into a refrigeration station to become a large condenser for one or several chillers. We use chillers to produce chilled water and boilers to produce hot water. Therefore, compared to dispersed air conditioning systems, an additional feature is added: 1. The use of circulating cooling water, cooling water pipelines, cooling towers, cooling water pumps, and other centralized high-efficiency heat dissipation (water as an intermediate medium for energy transfer). 2. Circulating chilled water (hot water), chilled water (hot water) pipelines, chilled water (hot water) pumps, etc. are used to circulate cold and hot water (water serves as an intermediate medium for energy transfer) between the cold and heat sources and the end equipment. 3. Air ducts are used to transport processed air between the AHU and each air-conditioned room in a centralized air conditioning room.

Therefore, centralized and semi centralized air conditioning systems need to be planned and designed in advance: the location of the central air conditioning room, central refrigeration station, boiler room, cooling tower, pipeline wells for pipeline layout, the design of the main pipeline and many branch pipelines, especially the careful design and calculation of the hydraulic balance of the pipeline system... Various equipment loads (considering their load requirements in the structural profession), required auxiliary power systems, control systems Related auxiliary facilities..... These projects require system design by HVAC engineers from the design unit before investment and construction, and include a large number of HVAC design modifications caused by scheme modifications. The design of public buildings also needs to comply with a large number of relevant national standards. It is precisely for this reason that a branch of HVAC engineers has emerged: HVAC engineers working in survey and design units. One of the main tasks of survey and design engineers is to design additional parts of centralized and semi centralized air conditioning systems compared to dispersed air conditioning systems.

Although centralized large chillers and cooling towers have significantly improved refrigeration efficiency and heat dissipation efficiency compared to small units in dispersed air conditioning systems. But the additional intermediate energy transfer media systems, such as chilled water (hot water) systems, cooling water systems, and air duct delivery and distribution systems, also require significant additional energy consumption from their pumps and fans.

The most common type of household air conditioning system, such as window type air conditioners or split type air conditioners, directly concentrates air handling and heat and cold sources together without the need for separate air-conditioned rooms. Split type air conditioners only need to reserve a bracket position for outdoor units or a small platform for installation on outdoor walls. The most common type of household air conditioner is directly provided by the seller to the manufacturer for subsequent services. Often, it is not necessary for specialized HVAC engineers to conduct professional design first (just leave a separate circuit loop as a dedicated household appliance), and the investment is also the responsibility of the household owner. The equipment selection is often based on the empirical values of the cooling and heating loads in each region (without the need for detailed cooling and heating load calculations), so the installation capacity of the equipment is relatively flexible, which also exposes many problems. Of course, if we could consider the different climates in different regions and have better design, calculation, and analysis, it would be more reasonable. The upcoming app will do more work on household air conditioning.

The author only divides air conditioning systems into three categories: centralized air conditioning, semi centralized air conditioning, and dispersed air conditioning, without further classification. The nature of other air conditioning systems, which are divided into more forms, is similar to the most ordinary household air conditioning, with too many classifications, which is confusing. (The author himself graduated from Xi'an Jiaotong University, specializing in design, construction, project management, software development and redesign, construction, project management and redesign. He is a senior engineer and also a registered public equipment engineer. Of course, he has also developed a professional software that generates two modes of high-precision psychrometric chart simultaneously, and discussed his professional views with HVAC engineers.)

It is only because of the different requirements and methods of using air conditioning that these different forms of air conditioning systems have emerged. This is why there are different career directions for HVAC engineers: 1. Investors (operation and maintenance, planning, acceptance, management...); 2. Important equipment manufacturers such as chillers, AHUs, FCUs, cooling towers, etc. (pre-sales and after-sales services); 3. Survey and design unit (air conditioning system design); 4. Construction unit (planning, organizing construction and installation of air conditioning systems); 5. Project management (PM); 6. Units and projects that use air handling knowledge in various industries.

Why is HVAC so important? Now, as the spring of 2024 has just entered, many parts of the world have broken records for low temperatures, and scientists predict that 2024 will usher in the hottest summer ever... Need HVAC to save the world. Also: Why is humidity so important for ladies' beauty? How to moisturize correctly? How to maintain reasonable humidity in the air for infants?...

If there are many people interested, the app will iterate and update more calculations and analysis of air conditioning methods and psychrometric chart processes in the future: fan coil unit with outdoor air system, secondary return air system, variable air volume VAV system, and zone air conditioning... There are also data center air conditioning and so on (and let's discuss together: why should these air conditioning methods be used?). Follow X.com/hvacol, and Facebook. com/100011678140188, as well as hvacol. com, to get relevant information in a timely manner. If no one pays attention, it means there is no need, and there is no follow-up.

Due to well-known reasons, the author can only access X.com and Facebook through VPN, and VPN often cannot be used. Therefore, if I do not follow everyone in a timely manner, please be patient and wait for the author to successfully access VPN.

The main development milestones of hvacolPC are as follows: 1. The first version was developed in 1998. 2. In 2013, a special version for the Equipment Registration Engineer Examination was developed, which has a huge Thermal Moisture Ratio Scale (computers are not allowed during the examination, only paper psychrometric chart can be used). HVAC engineers and educational training institutions who participated in the examination have been using it until now. 3. In 2023, two modes (horizontal setting mode and vertical setting mode of dry bulb temperature axis) were simultaneously implemented High precision psychrometric chart software, namely hvacolPC 2023.

Kelvin.Wang
2-25-2024

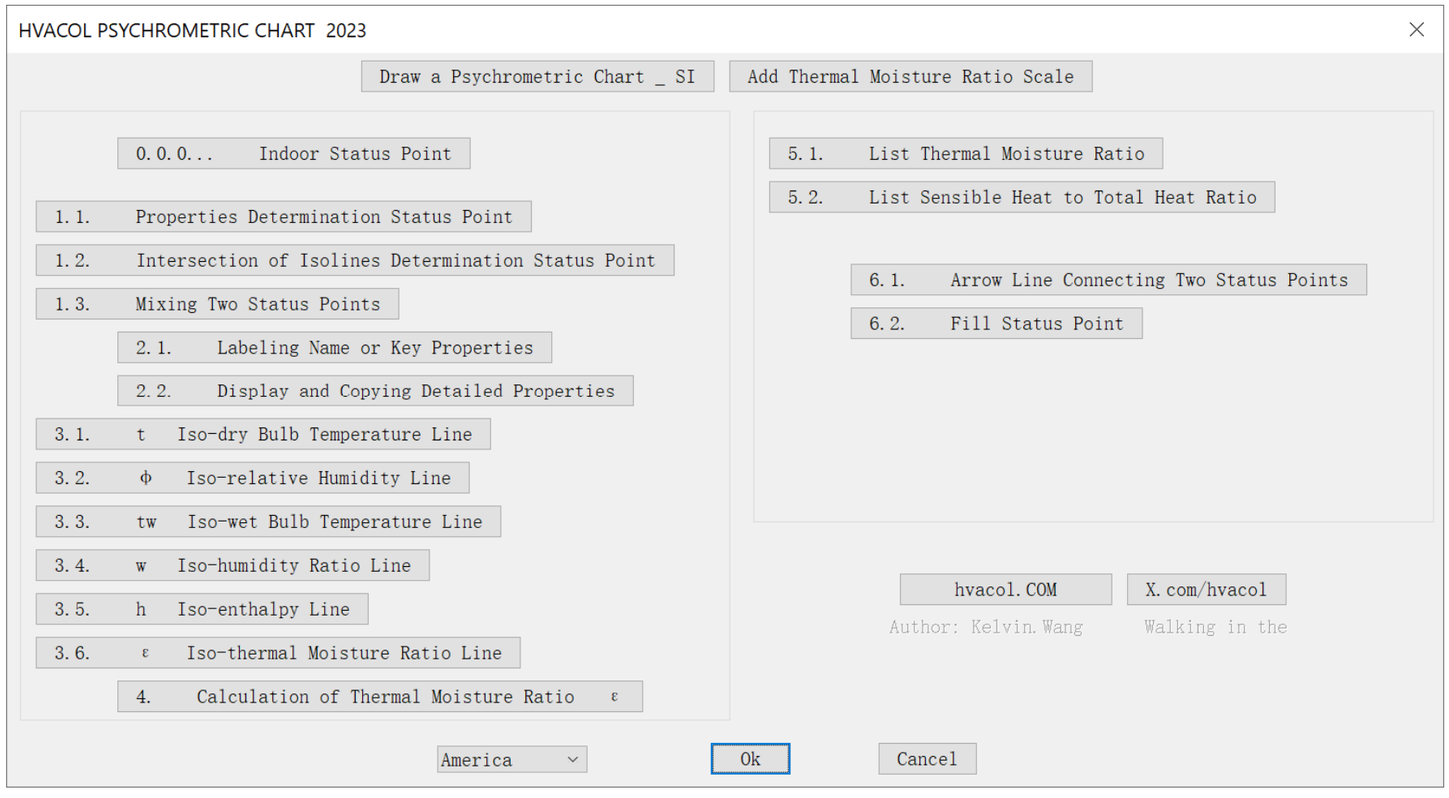
Step by Step of hvacolPC

Note:

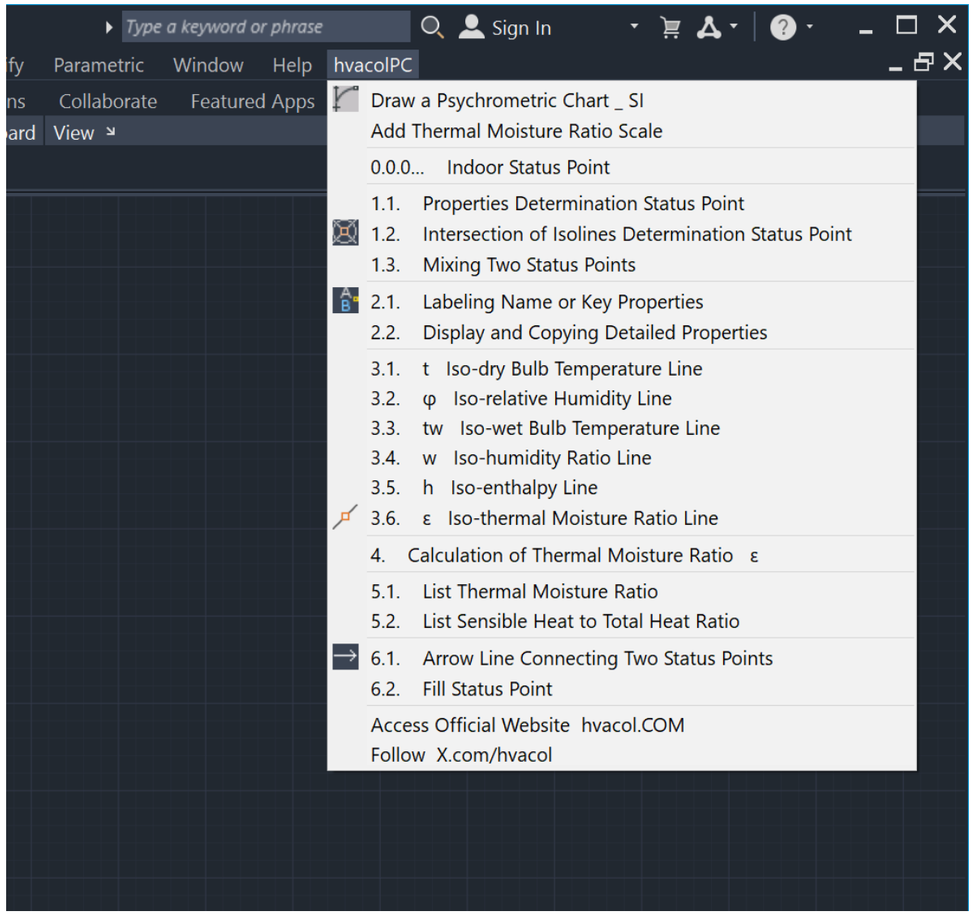
1. It is strictly prohibited to use the “Move” command to move the generated psychrometric chart as a whole or in part, and to use the “ROTATE” command to rotate the psychrometric chart as a whole or in part (the Thermal Moisture Ratio Scale can be moved as a whole but cannot be rotated). Because the “0” coordinate of the psychrometric chart coincides with the “0” coordinate of AutoCAD, the data of the state points is calculated based on the coordinates. Similarly, it is strictly prohibited to use the “SCALE” command to change the overall or partial size of the psychrometric chart. Attention: The movement and scaling here are changes to the position and actual size of the entity, rather than the “Zoom” view scaling command and the “PAN “ view movement command in the view. These two commands do not change the coordinates and entity size, but only visually zoom in, zoom out, and move, without any impact on the physical lines. Engineers using AutoCAD are aware of this, so I won't go into detail here.
2. Of course, each DWG document can only have one psychrometric chart.
3. At present, it is an international standard unit, and in the future, it will support both imperial and international standard units.

I、 HvacolPC menu interface

Complete the design, calculation, and analysis of psychrometric chart for all functions through these two menu interfaces (The effect is exactly the same):



Enter the "hvacolpc" command from the AutoCAD command line to bring up this menu interface.



Call up this menu interface from the AutoCAD pop-up menu.

II、 Function Description of hvacolPC

Click on the various options on the menu to run the various functions of the psychrometric chart software hvacolPC.

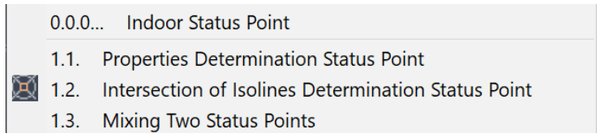
Primary functional group: Generating psychrometric chart



To conduct psychrometric chart design, calculation and analysis, it is necessary to first have a psychrometric chart: it can be generated using hvacolPC or downloaded in DWG format on hvacol.com that meets your own requirements. It can also be directly generated here, and it takes about 10 seconds to generate a high-precision psychrometric chart.

Menu option " Draw a Psychrometric Chart-SI ": Enter barometric pressure, press enter key directly to set the default value to 101325Pa, wait for about 10 seconds to generate the International System of Units psychrometric chart.
Menu option " Add Thermal Moisture Ratio Scale ": optional, does not affect psychrometric chart design, calculation, and analysis. Whether to run this option is up to the user's discretion.

Functional Group 1: Determine the Status Point

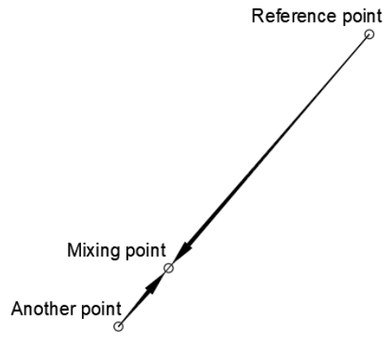


Moist air only has a state (temperature, humidity...) and no point.
Because different positional parameters are used on the psychrometric chart to express the different states of moist air. The expression of "points" at different positions is called "moist air status points". Because conceptually, the "point" is infinitesimal and cannot be enlarged, it is difficult to operate in practice, such as selecting, copying, or deleting points. Therefore, hvacolPC uses a small "circle" to represent this point, and its center position is the ideal moist air status point position. Choosing a "point" becomes selecting the corresponding "circle" entity, which is very convenient to operate.

The various processed states (property parameters) of moist air are reflected in the corresponding position status "points" on the psychrometric chart. So, the most important thing in designing, calculating, and analyzing the psychrometric chart of moist air is to determine the corresponding status points for each moist air state.
Once the status point is determined, draw a small special "circle" at that point position, with its center coinciding with the "point", and we call the "circle" the status point of moist air.

Menu option " 0.0.0... Indoor Status Point ": The indoor air status point is the most important point on the psychrometric chart. It is specifically integrated into a separate option in the software and is named "0.0.0..." by default. This method reveals the secrets of the universe (to be explored in the creation of HVAC professional e-books).
Menu option “ 1.1 Properties Determination Status Point ": Two options determine the status point: 1. Dry bulb temperature, Wet bulb temperature 2. Dry bulb temperature, Relative humidity [1/2]: Press the number keys "1" or "2" to enter different categories.
Menu option “ 1.2 Intersection of Isolines Determination Status Point ”: The intersection point of contour lines determines the status point (with automatic capture of "intersection points" function, very easy to locate on the intersection point)
Menu option “ 1.3 Mixing Two Status Points ": The moist air status (points) after mixing two states (points) of moist air. There are two options: 1. Reference point, other point ->mixing point 2. Reference point, mixing point ->other point [1/2]:

Explanation for "Reference point", "Another point", and "Mixing point":



" Reference point ": A reference point is only when there is data on the proportion of moist air volume in this state to the total air volume after mixing. For example, when outdoor moist air is mixed with indoor moist air, the proportion of outdoor moist air volume to the total air volume after mixing is generally 20%, which is 0.2 (i.e., the software prompts to enter: Enter reference status point airflow ratio value (0,1):. 2). The outdoor moist air state (point) here is referred to as the "reference point". The indoor moist air state (point) is called "Another point", and the state (point) of mixing two states of moist air (such as a return air) is called "Mixing point"

Sometimes, we know the " Reference point " and have pre designed a certain mixed moist air state (point) called the " Mixing point ". To calculate the " Another point " moist air state, we can enter the number key "2" to complete the calculation analysis and determine the position of the point(2.Reference point, mixing point -> another point).

Functional Group 2: Properties of Status Point

2.1. Labeling Name or Key Properties
2.2. Display and Copying Detailed Properties

Label the name of the status point and the moist air properties (key and detailed properties. Detailed properties can be copied to the clipboard to transfer data).

Menu option " 2.1. Labeling Name or Key Properties ": Label the name of the status point and the key properties of the moist air at that point.
Menu option " 2.2 Display and Copying Detailed Properties ": Display and copy detailed properties of status point.

Functional Group 3: Isolines

3.1. t Iso-dry Bulb Temperature Line
3.2. φ Iso-relative Humidity Line
3.3. tw Iso-wet Bulb Temperature Line
3.4. w Iso-humidity Ratio Line
3.5. h Iso-enthalpy Line
3.6. ε Iso-thermal Moisture Ratio Line

Draw 6 contour feature lines, Menu option from 3.1 to 3.5 are drawn in two ways: 1. Draw by a value; 2. Draw through status points. Menu option 3.6 is drawn simultaneously with values and through state points.

Functional group 4: Calculation of Thermal Moisture ratio

4. Calculation of Thermal Moisture Ratio ε

This menu option is often combined with menu option 3.6 to calculate the required Thermal moisture ratio value for menu option 3.6 (pay attention to consistent units when entering data).

Functional group 5: Two status point process data

5.1. List Thermal Moisture Ratio
5.2. List Sensible Heat to Total Heat Ratio

List the Thermal moisture ratio, sensible heat to total heat ratio, and temperature difference, humidity ratio difference, and enthalpy difference of moist air when processed from state (point) 1 to state (point) 2. The result is related to the order of selecting state points 1 and 2.

Functional Group 6: Status Point Assistance

6.1. Arrow Line Connecting Two Status Points
6.2. Fill Status Point

Use arrow lines to connect two status points and fill the status points (making the status points more like a real point...)

III. Perform psychrometric chart design, calculation, and analysis on a virtual primary return air summer air conditioning project to quickly learn hvacolPC

Example:

A public air-conditioned office in a certain office building, with a summer barometric pressure of 101325Pa; The indoor air design properties are: 24 °C, relative humidity ϕ= 50%; Cold load 35.8kW, water load 9.5kg/h; Outdoor air design data: dry bulb temperature: 34 °C, wet bulb temperature: 28 °C;

Adopting a primary return air conditioning system, the outdoor air accounts for 20% of the total supply air volume; Calculate the equipment capacity of the air conditioner (air cooler treated to a relative humidity of 95%).

3.1 Open an existing psychrometric chart or generate a new psychrometric chart. Generate a new psychrometric chart here. Click on the menu option: 

,Enter to confirm the default barometric pressure value of 101325Pa (if the barometric pressure in the design project area is inconsistent, please enter the barometric pressure design value for the area. The input value is greater than or equal to 26000Pa, less than or equal to 108000Pa), and generate a psychrometric chart.



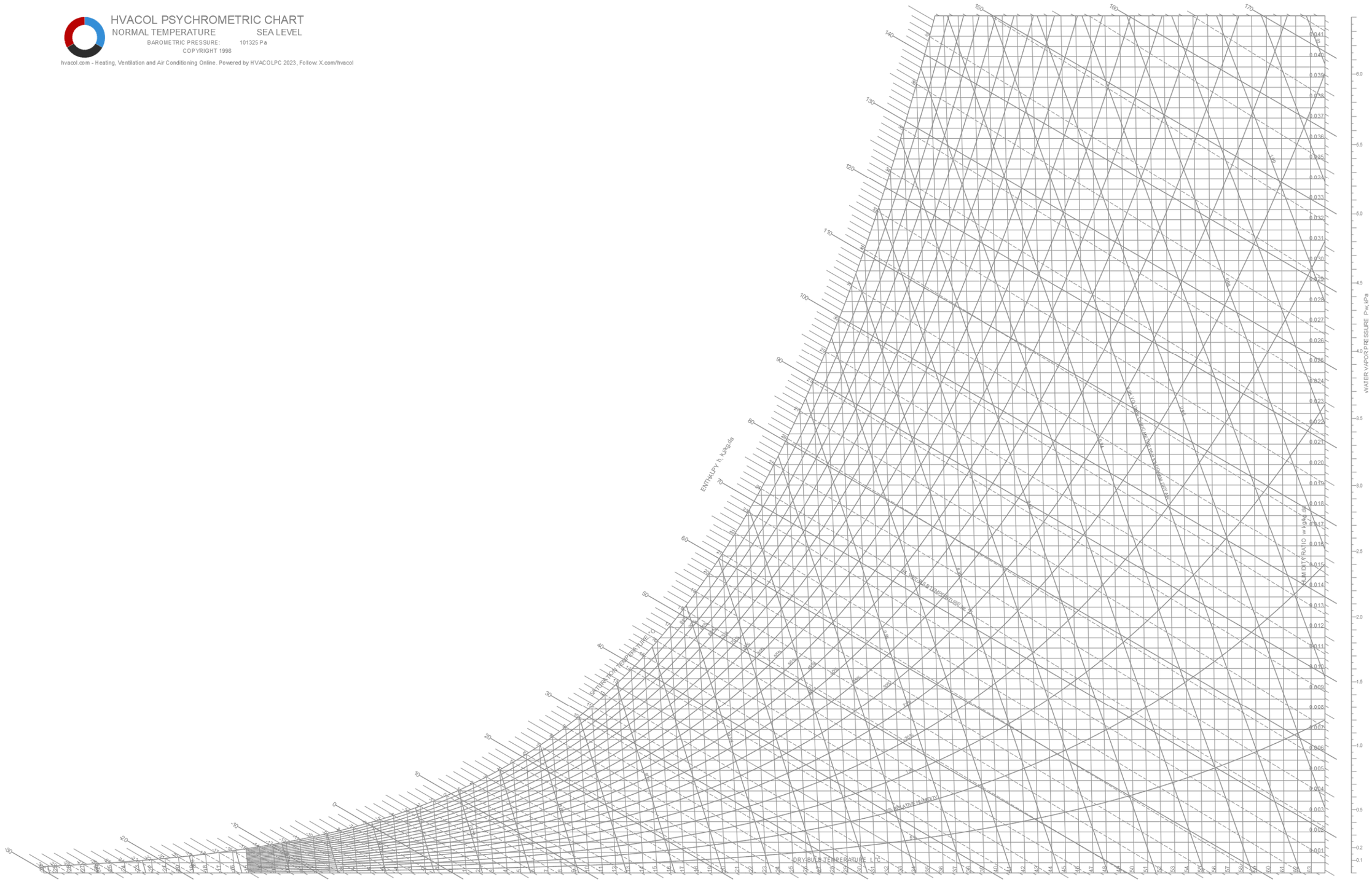
HVACOL PSYCHROMETRIC CHART

NORMAL TEMPERATURE SEA LEVEL

BAROMETRIC PRESSURE: 101325 Pa

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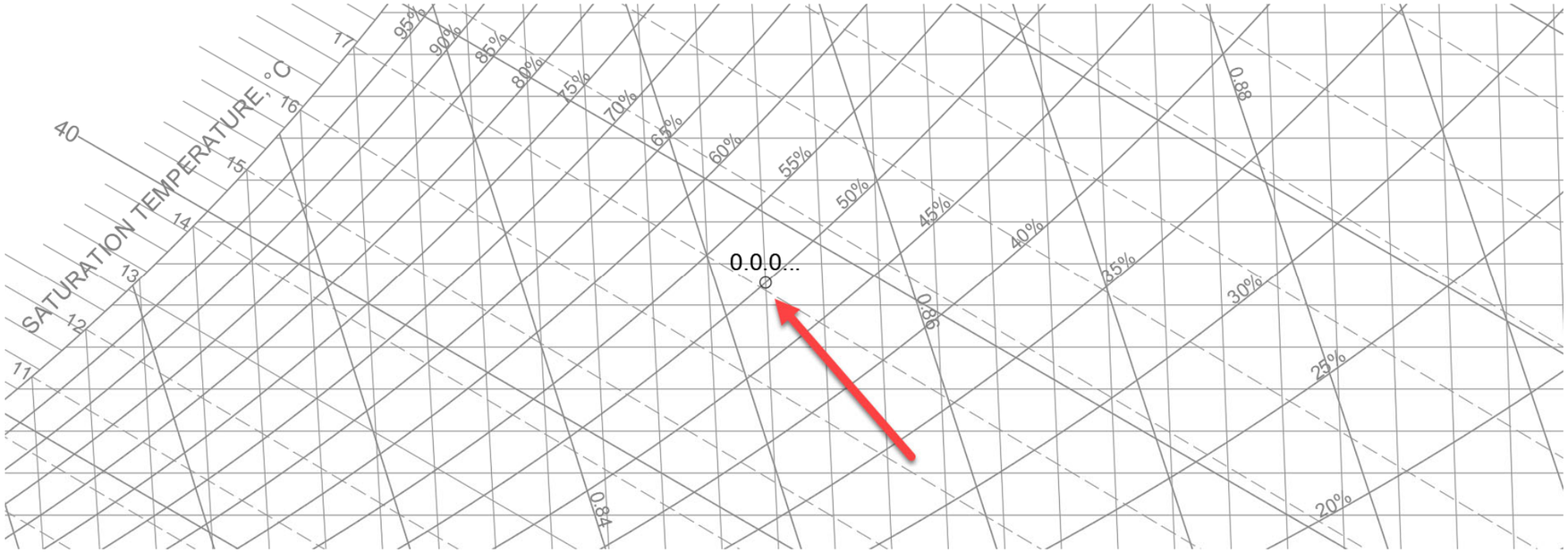


3.2 Determine the location point of indoor air status properties on the psychrometric chart. Click on the menu option: `0.0.0... Indoor Status Point`, and enter the corresponding value:

```
Enter indoor dry-bulb temperature  t, °c [-30, 64]: 24
```

```
Enter indoor relative humidity  ϕ (%) (0, 100]: 50
```

Draw a small circle on the psychrometric chart, representing the point of indoor air state.



Indoor air status point can also be confirmed using menu option `1.1. Properties Determination Status Point`

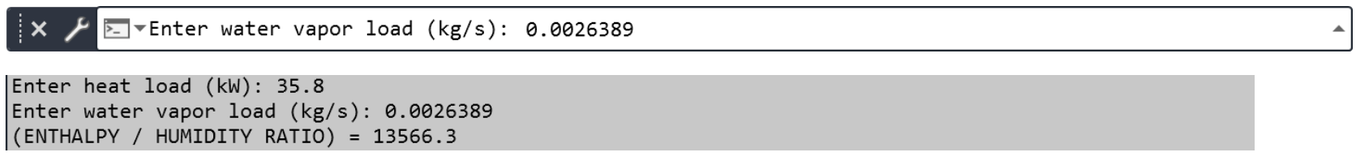
3.3 Determine the state "point" of the moist air state during the cooling air supply after the cooler cools.

Calculate the thermal moisture ratio. In the software, the unit of water vapor load is kg/s, and the virtual project is kg/h, so the water vapor load of 9.5kg/h is converted to 9.5kg/3600s=0.0026389 kg/s; Click on the menu option `4. Calculation of Thermal Moisture Ratio ε` and enter:

```
1.By heat load, water vapor load   2.By Δh, Δw [1 2]:
```

Press the number key "1" here

```
Enter heat load (kW): 35.8
```

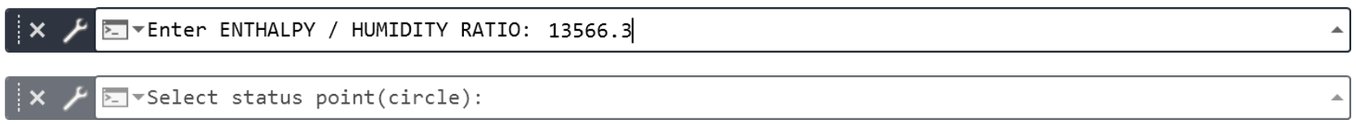


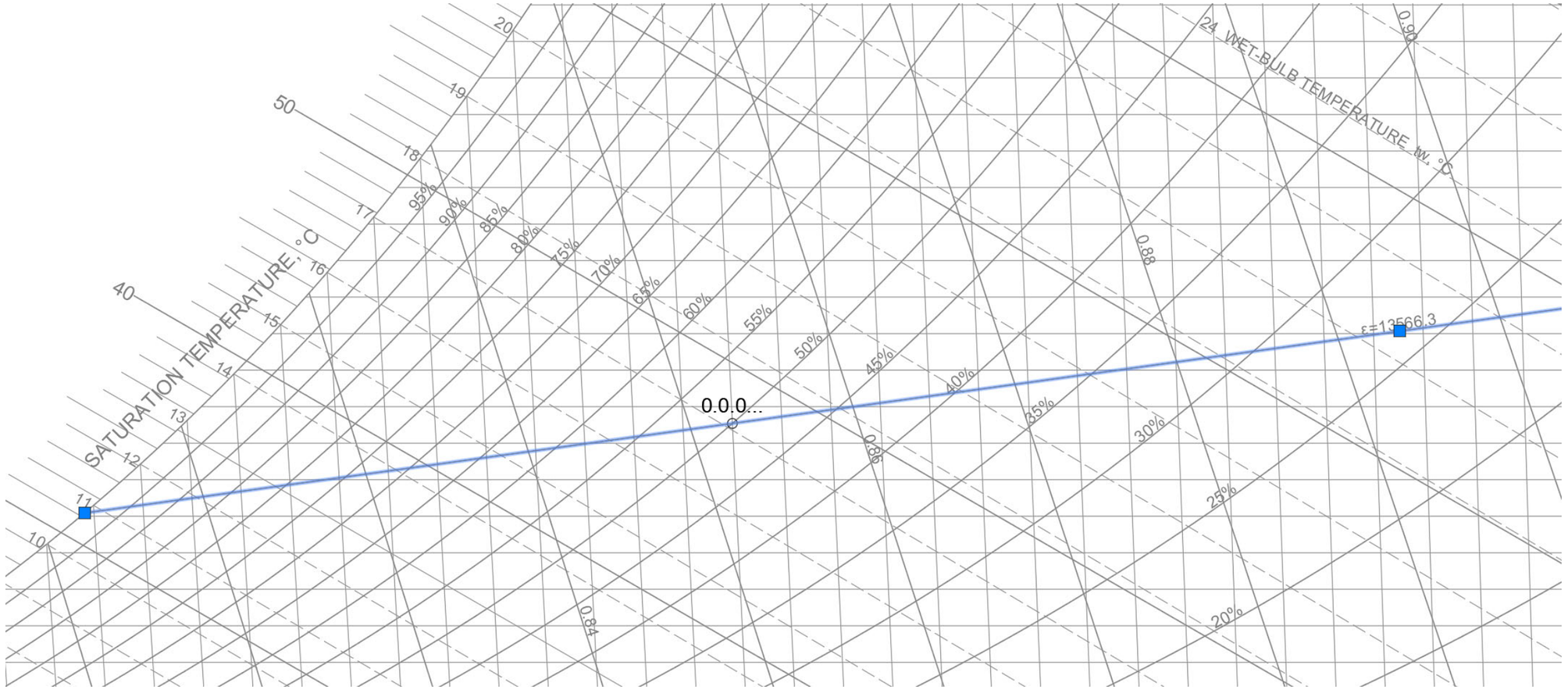
Calculation result: (ENTHALPY / HUMIDITY RATIO) = 13566.3

So, the state "point" of the moist air state when the cooler cools the air and supplies air is not only on the iso-thermal moisture ratio line with a value of 13566.3, but also on the 95% relative humidity line (when the air cooler is processed to 95% relative humidity). The intersection of these two lines is the state "point" of the moist air state when the cooler cools the air and supplies air that meets the requirements.

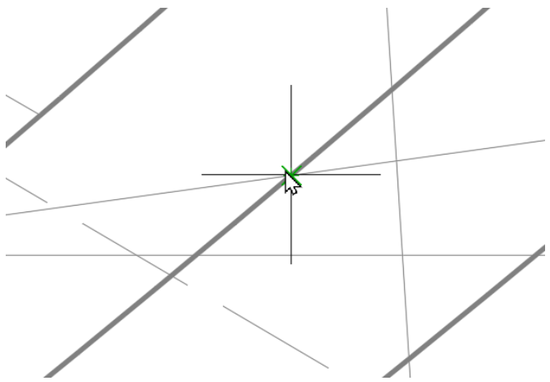
3.3.1 Draw an iso-thermal moisture ratio line with a value equal to 13566.3 through indoor moist air status points. Click on the menu option 

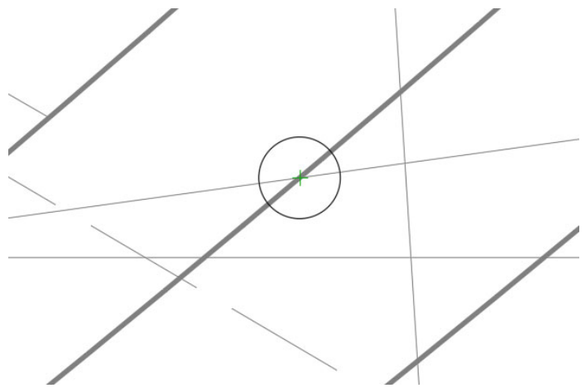
, enter: 13566.3, and then select the indoor moist air status point (circle).

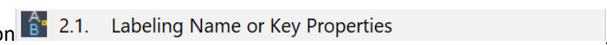




3.3.2 Intersection determination status point (with automatic capture of intersection function). Click on the menu option 1.2. Intersection of Isolines Determination Status Point, move the mouse to the intersection of two lines, and immediately automatically capture the screenshot shown below. Click the left mouse button to draw the point (circle)

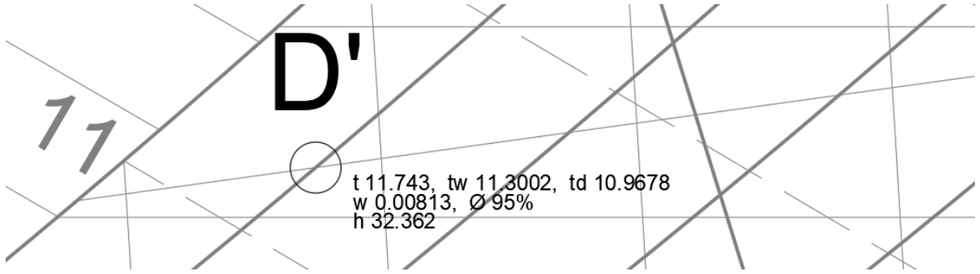




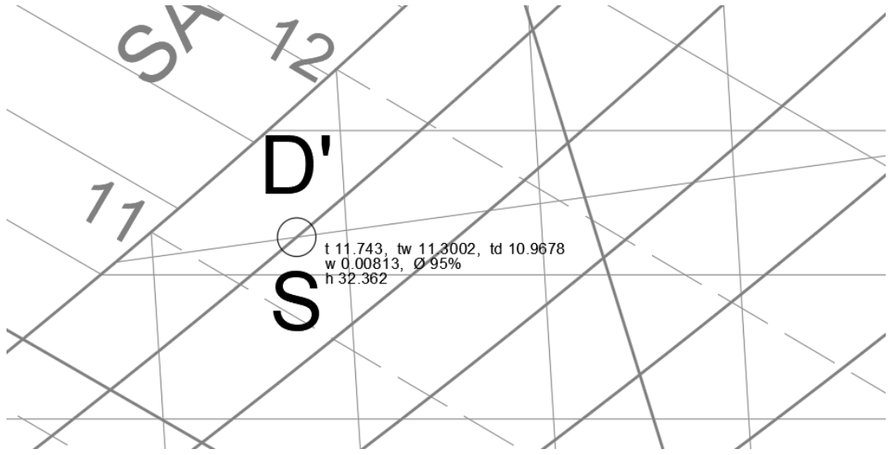
We name this point as machine dew point D '(i.e. theoretical dew point, named D, then machine dew point is named D'). Click on the menu option 

, press the number key "1", then enter "D’", and then select the point (circle).

Click on the menu option, press the number key "2", and then select the point (circle) named "D’" to obtain the key properties, as shown in the figure:

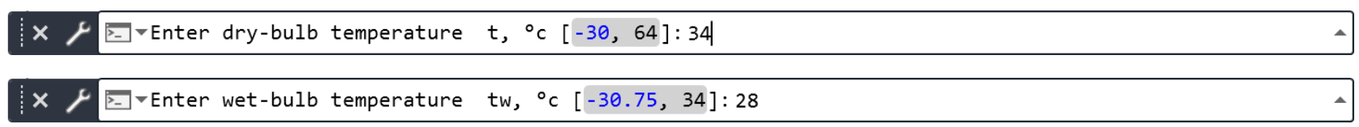


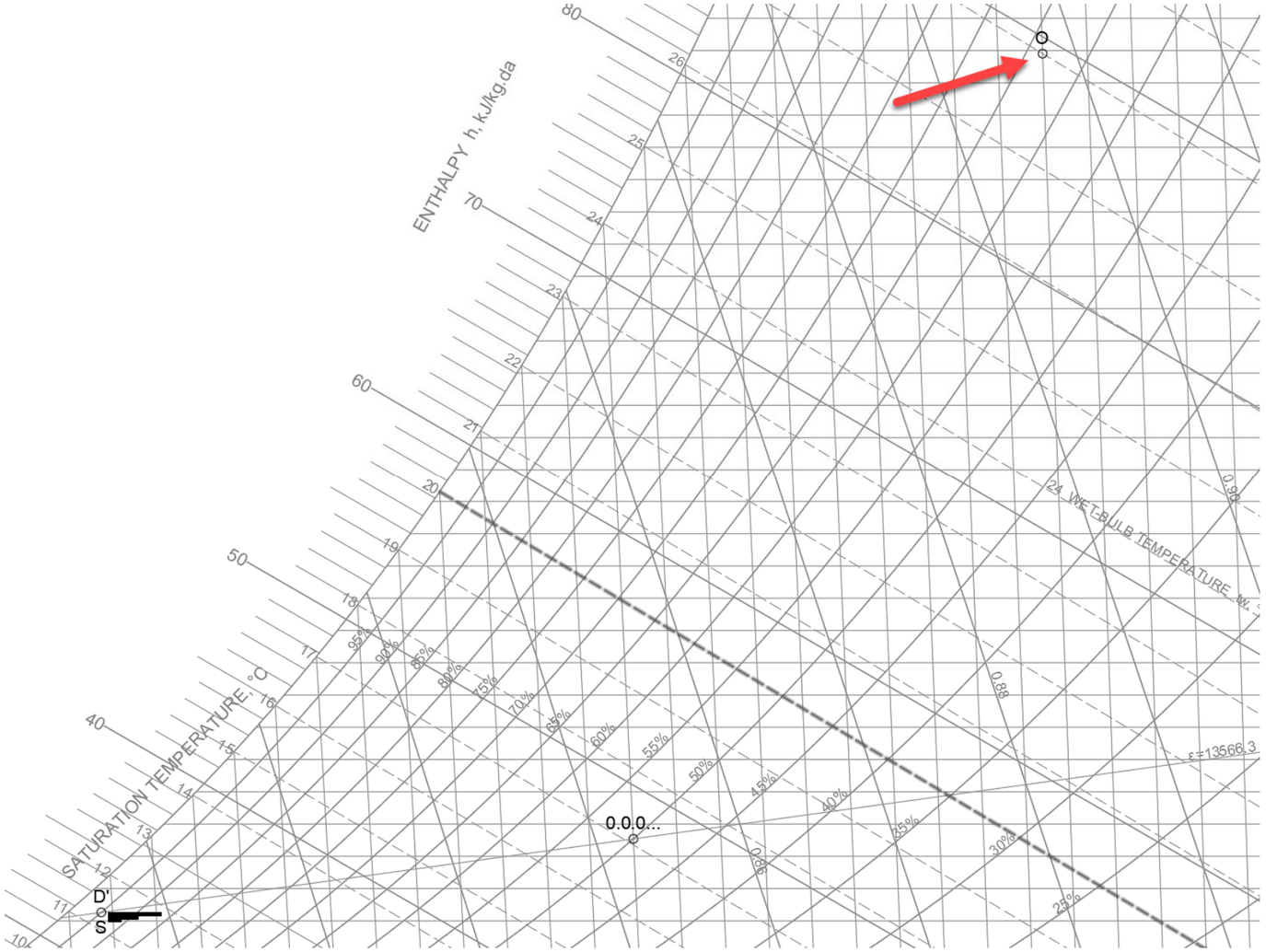
Direct machine dew point air supply, also known as the moist air status “D ’”point, is our moist air status point “S” during air supply. Mark point S as shown in the figure:



3.3 Determine the state "point" of the outdoor moist air state.

Select the menu option 1.1. Properties Determination Status Point, press the number key "1", enter the dry bulb temperature "34" and wet bulb temperature "28", draw the status point, and name it "O" (Outdoor air),



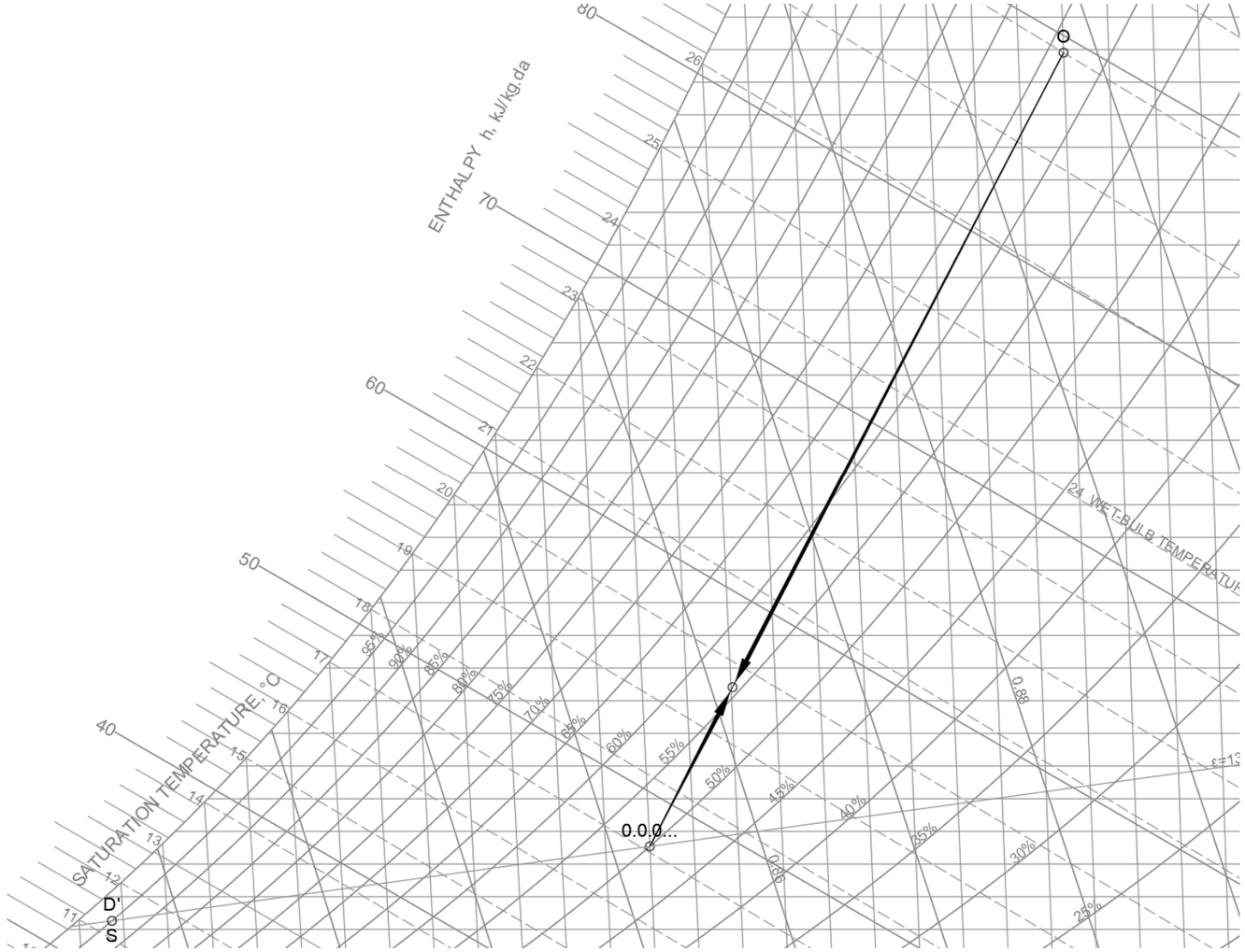


3.4 Determine the state "point" of mixing outdoor and indoor moist air.

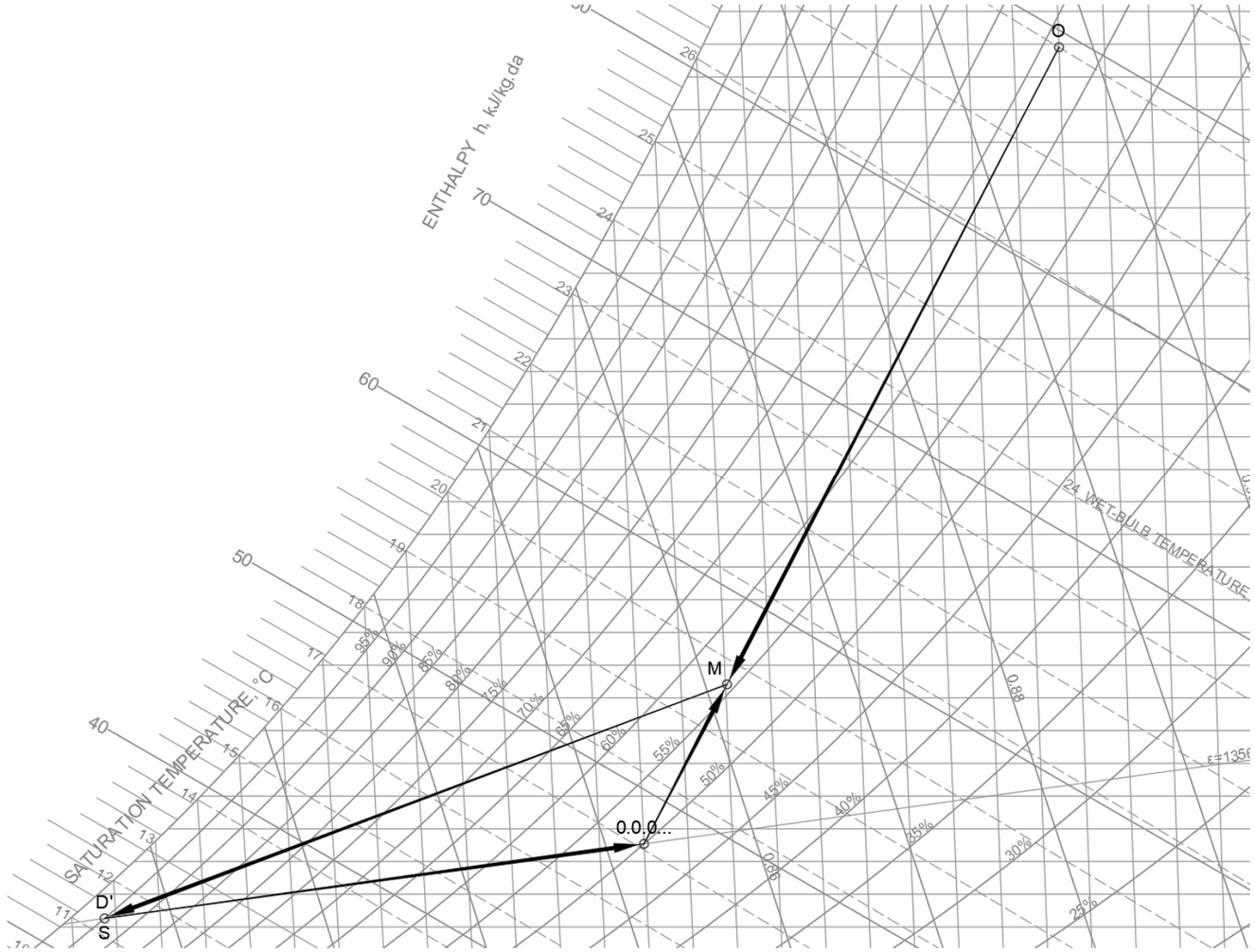
Here we know that outdoor moist air accounts for 20% of the total flow after mixing, so the outdoor moist air state "point" is "Reference point", and the indoor moist air state "point" is "Another point". Select the menu option 1.3. Mixing Two Status Points, press the number key "1", follow the prompts to select two points (circles), and then enter "0.2",

```
Enter reference status point airflow ratio value(0, 1): .2
```

Then hvacolPC completes the calculation and drawing of the mixing points:



Name the mixing point “M” (Mining point), then select the menu option 6.1. Arrow Line Connecting Two Status Points and use arrow lines to connect M ->D’(S) -> 0.0.0... as shown in the figure:



Click on either menu option

5.1. List Thermal Moisture Ratio
5.2. List Sensible Heat to Total Heat Ratio

5.1 or 5.2, and in the order of selection, the enthalpy difference obtained from 0.0.0... to S and M to D 'is:

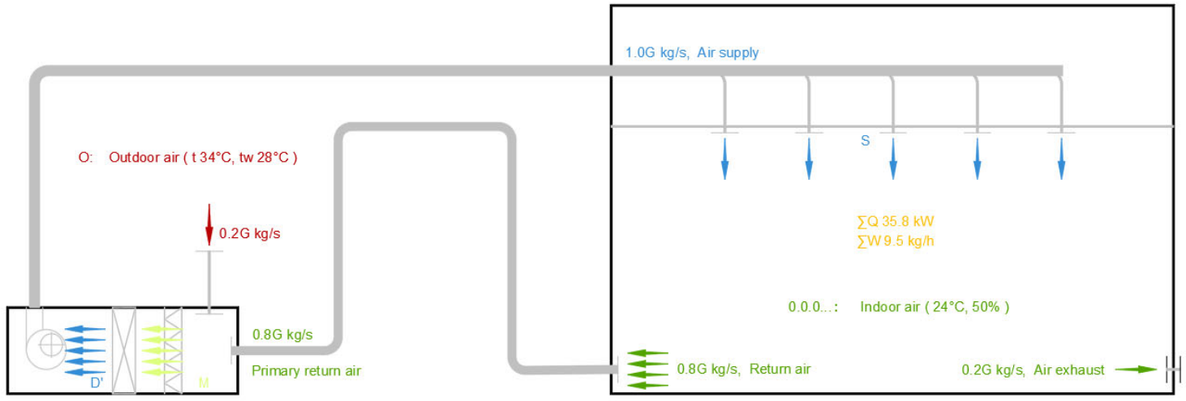
```
|(ENTHALPY / HUMIDITY RATIO) = 13566  (Δt 12.26 °C,  Δw 0.00114 kg/kg.da,  Δh 15.463 kJ/kg.da)
|(ENTHALPY / HUMIDITY RATIO) = 6644  (Δt 14.29 °C,  Δw 0.00358 kg/kg.da,  Δh 23.76 kJ/kg.da)
```

The enthalpy difference from 0.0.0... to S is Δh1=15.463 kJ/kg.da; The enthalpy difference from M to D'is Δh2=23.76 kJ/kg.da;

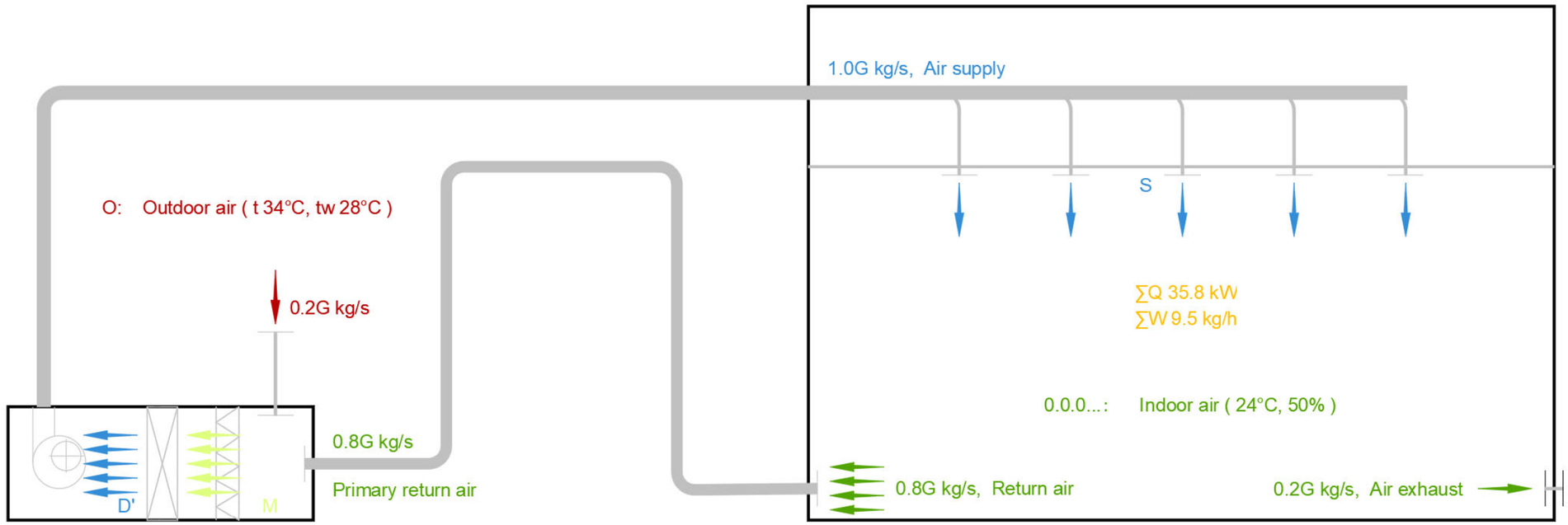
Total air supply volume of the system: G = ∑Q /Δh1 = 35.8kW / 15.463 kJ/kg.da = 2.3152 kg/s

Equipment capacity of air conditioner: Q = G *Δh2 = 2.3152 * 23.76 = 55.009 kW

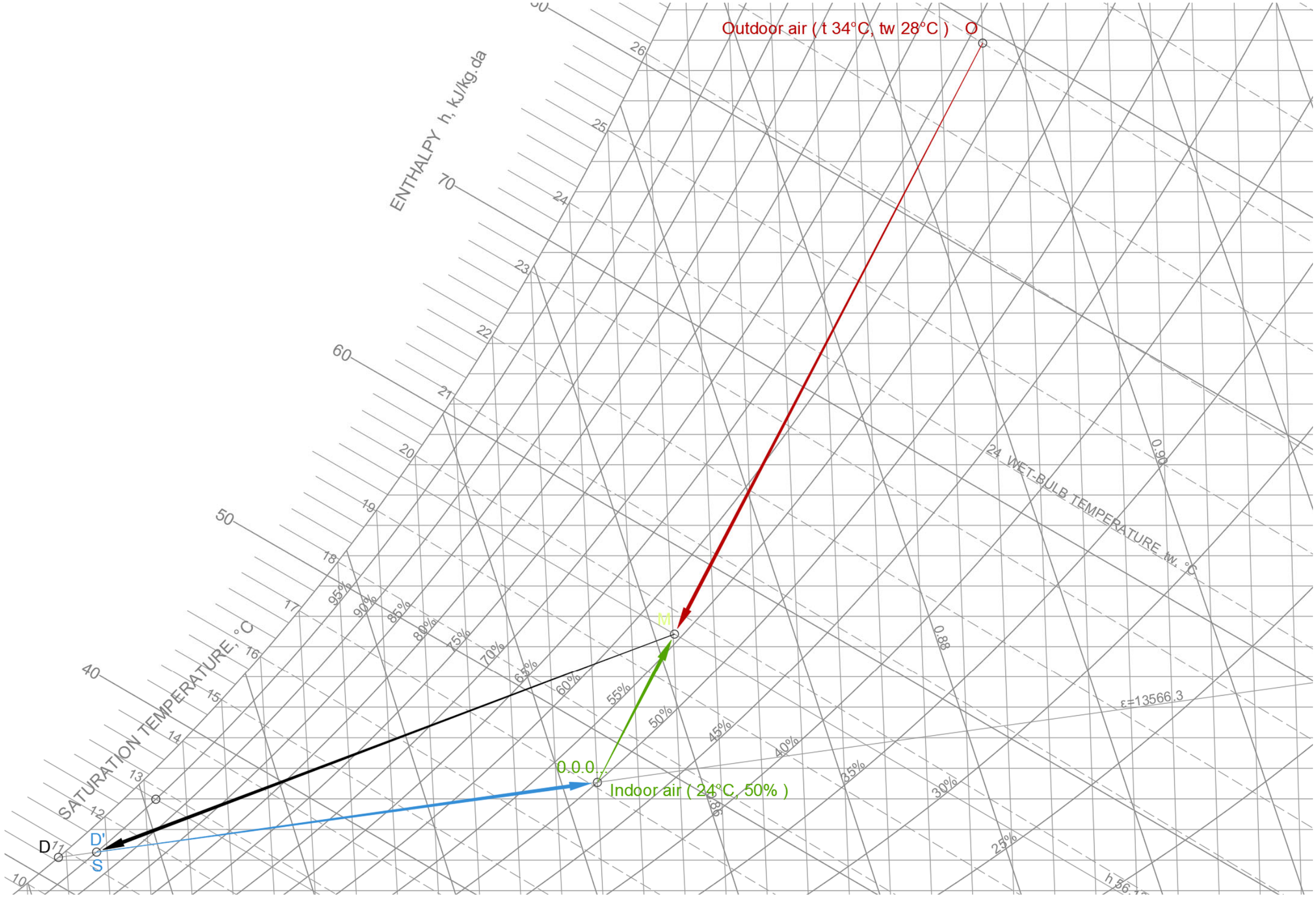
Finally, different colors were used to label the psychrometric chart. And a schematic diagram of the summer primary return air conditioning system was drawn, with corresponding color markings on the schematic diagram, as shown in the figure:



Primary Return Air System - Summer



Primary Return Air System - Summer


Outdoor air (t 34°C, tw 28°C)
O
ENTHALPY h, kJ/kg.da
SATURATION TEMPERATURE, °C
24 WET-BULB TEMPERATURE tw, °C
lvf
0.0.0
Indoor air (24°C, 50%)
D'
D
S
ε=13566.3