|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Row** |  | **Item** | **Source** | | **Units** |  |  | | |  |  |  | | |  |
| 2 | **Plans** | First – split design layout into duct sections; eg A-C, B-C, C-D, D-E etc | | | | | | | | | | | | | |
| Duct ID |  | | eg A-B |  |  | | |  |  |  | | |  |
| Now add in for each section the flowrates you have previously calculated – starting with the hoods (all hoods added together = fan flowrate) | | | | | | | | | | | | | |
| Design Flowrate, “**Q**” |  | | m3/s |  |  | | |  |  |  | | |  |
| Slotted Hood? (If “yes” = row 3, if “no” = row 10) | | | |  |  | | |  |  |  | | |  |
| 3 | **Slots/Plenums** | Slot Area | |  | m2 |  |  | | |  |  |  | | |  |
| 4 | Slot Velocity | |  | m/s |  |  | | |  |  |  | | |  |
| 5 | Slot **Vp** | |  | Pa |  | **This greyed-out section is only if you have slot type hoods - Not used in Course Design Example?** | | | | | | | |  |
| 6 | Entry Loss Factor | | 1.78 if slot hood attached to leg | - |  |  | | |  |  |  | | |  |
| 7 | Acceleration Factor | | 1.0 is slot hood attached to leg | - |  |  | | |  |  |  | | |  |
| 8 | Plenum Loss Factor | | R6 + R7 |  |  |  | | |  |  |  | | |  |
| 9 | Plenum **Sp** | | R5 x R8 | Pa |  |  | | |  |  |  | | |  |
| 10 | **Ducts** | Next, we need to decide what duct diameter we are going to actually install.  This part of the exercise is done in a couple of steps.  The first step is to decide what minimum duct velocity you are going to choose in each duct section (depending on the system and process – it may be the same Transport Velocity in every section of duct).  SELECT your Transport Velocities and enter for each duct section in the row below. | | | | | | | | | | | | | |
| Transport Velocity required | | From Tech Pack table | m/a |  |  | | |  |  |  | | |  |
| Next step is to find the EXACT duct diameter that would ensure we got the above Transport Velocity (exactly) in each duct section.  To do this you take the flowrate (Q) in each duct section (Row 2) and you divide that by the Transport Velocity (as selected in row above).  That gives you an “ideal duct Area” – ie a duct of that Area would give you exactly the Transport Velocity.  From that “ideal” area we then convert back to a diameter – to do that use the equation in your Technical Pack. The answer will be in ‘metres’. Multiply by 1000 to get to millimetres (mm) and put the “Ideal Duct Diameter” for each duct section in the row below. | | | | | | | | | | | | | |
| Ideal Duct Area | | See above | m2 |  |  | | |  |  |  | | |  |
| Ideal Duct Diameter | | See above | mm |  |  | | |  |  |  | | |  |
| Now – you will be very unlikely to get an “ideal” duct (as above dimension) that you can actually purchase. The “ideal” diameter will be between Standard available duct sizes.  Do you choose the next standard (available) size ‘Up’ or next standard size ‘Down’?  If you go ‘Up’ – that will increase the Area of the duct and therefore decrease the velocity below Transport Velocity.  You therefore always choose a standard available duct size ‘Below’ the ideal duct diameter. Some Standard sizes as listed on a page of your Technical Pack. | | | | | | | | | | | | | |
| Duct Diameter to be Installed | | See above | mm |  |  | | |  |  |  | | |  |
| 11 | Duct - Area | | Πr2 or Πd2/4 | m2 |  |  | | |  |  |  | | |  |
|  | Now you know both the Diameter of the duct you are going to use in each section – and have calculated the Duct Areas.  What you must now do is re-calculate what Velocity you will actually have in the (as installed) duct. You initially chose a Transport Velocity – but had to select a duct diameter slightly smaller than “Ideal”. That had the effect of increasing slightly the velocity in each duct section.  The issue is that the Pressure Loss in a duct is proportional to the Duct Velocity – so we now need to calculate the exact Duct Velocity we will have in the “as installed” duct. To do this Take the Flowrate (Q) in the duct section and divide it by the “as installed” Duct Area (A) | | | | | | | | | | | | | |
| 12 | Actual Duct Velocity | | R2 ÷ R11 = V | m/s |  |  | | |  |  |  | | |  |
|  | In our method of calculating Pressure Losses, we use “**fractions of the Velocity Pressure**” - so we need to convert the actual Duct Velocities back to Velocity Pressure (below) | | | | | | | | | | | | | |
| 13 | Actual Duct **Vp** | | Use Row 12 value and (V/1.29)2 | Pa |  |  | | |  |  |  | | |  |
| 14 | Duct Length | | Taken from Plans | m |  |  | | |  |  |  | | |  |
|  | Pressure losses occur in straight duct due to friction. The losses can be calculated either from the graph/table in the Technical Pack or using the automated calculator in the Pressure Loss Excel Spreadsheet. Note: There will be slight differences between the answers in each method (but they will usually be small/insignificant) | | | | | | | | | | | | | |
| 15 | Friction Factor (**F’d**) | | From Spreadsheet, Equation or Nomograph | Vp/m |  |  | | |  |  |  | | |  |
|  | **VP Factors** | The chart – and the Spreadsheet - obviously calculate the “Losses” – for straight, smooth-bore ducting – expressed as a “fraction of the Velocity Pressure”.  Spiral wound and flexible ducting will need a correction factor (from tables or manufacturer) to correct for this. Decide on any correction factor and enter in row below. | | | | | | | | | | | | | |
| 15a | Roughness Factor | |  |  |  |  | | |  |  |  | | |  |
| 16 | Actual Friction in Duct | | Rows 14x15x15a | - |  |  | | |  |  |  | | |  |
|  | The above row gives the total Pressure Losses in the straight duct sections. Now we need to add Losses for Hood Entries, Bends, Branch Entries, Discharge Cones etc – where they exist.  Start with the Hoods and find the style of hood which most closely equates with a drawing in the Technical Pack table on Hood Losses. | | | | | | | | | | | | | |
| 17 | Hood Entry Loss | | From Figures on Tech Pack diagrams | - |  |  | | |  |  |  | | |  |
|  | Next we need to consider Acceleration Losses; perhaps the most difficult one to get to grips with?  Consider that at some point the air outside the hood will be stationary. It then has to get up and move at the velocity required at the Hood Entrance (Hood entry Velocity pressure) – so the air goes from 0Pa to 1 Vp (Pa).  We therefore have to account for this extra energy in the form of a ‘Loss’ and we do this by putting a 1 Vp loss in each duct section ….. but only where there is a Hood fitted to that duct branch section. | | | | | | | | | | | | | |
| 18 | Acceleration | | Add in a value of 1.0 in the column **ONLY** if there is a hood attached to that particular leg | - |  |  | | |  |  |  | | |  |
| 19 | Elbows | | From Images in Tech Pack | - |  |  | | |  |  |  | | |  |
| 20 | Branch Entry | | From Images in Tech Pack. Add to duct sections which is doing the joining to the main duct | - |  |  | | |  |  |  | | |  |
| 21 | Other (a) | | Eg Discharge Cone | - |  |  | | |  |  |  | | |  |
| 22 | Other (b) | |  | - |  |  | | |  |  |  | | |  |
|  | Adding up these Loss Factors gives us (below) the Total System Losses – but they are of course expressed as “fractions” of that particular duct leg Velocity Pressure (Vp) | | | | | | | | | | | | | |
| 24 | Total Loss Factor | | Add up rows16-23 | - |  |  | | |  |  |  | | |  |
|  |  | Now we need to convert these Losses to actual Losses expressed as Pascals (as opposed to fractions of the Vp).  To do that we simply multiply the Fraction of the Vp losses in each of the Row 24 duct sections (above) by the actual Velocity Pressure in that duct section (ie Row 24 x Row 13) | | | | | | | | | | | | | |
| 25 | **SP Losses** | Duct **Sp** Loss | | Rows 13x24 | Pa |  |  | | |  |  |  | | |  |
|  | In some cases, manufacturers of components, eg filters will give their equipment losses as straight Pascals (Pa).  Most common would be - filters.  In such cases enter the item and the Pressure Loss (as Pascals) in the section below.  Be careful to insert the loss in the correct duct section. | | | | | | | | | | | | | |
| 26 | Other Equip Losses (a) | | ***eg a filter where PD given in pure Pascals*** | Pa |  |  | | |  |  |  | | |  |
| 27 | Other Equip Losses (b) | | - | Pa |  |  | | |  |  |  | | |  |
| 28 | Other Equip Losses (b) | | - | Pa |  |  | | |  |  |  | | |  |
|  | Where you have ducts joining a main duct (eg via a ‘Y’ section) – if the velocities in the three elements of duct at the ‘Y’ vary by more than 20% from each other - then you will need to do the “duct pressure loss correction” calculation (see notes – or even better use the insert panel in the Excel Spreadsheet).  Enter values below in appropriate duct section. | | | | | | | | | | | | | |
| 29 | Junction **Vp** Change | | Only enter values if Vel (m/s) changes by more than 20% in each leg at junction | Pa |  |  | | |  |  |  | | |  |
|  | Now we are ready to add up the Pressure Losses in each duct leg (below) | | | | | | | | | | | | | |
| 30 | Total **Sp** Losses | | Sum all rows rows 9, 25-29 | Pa |  |  | | |  |  |  | | |  |
|  |  | To get the Whole System Losses for the purpose of Fan Specification we first need to determine from all the legs with hoods attached ….. which leg has the greatest pressure loss (as that will be classed as the “Governing” leg).  So in the Row below we say “Yes” or “No” only in the sections of duct with a Hood attached. | | | | | | | | | | | | | |
| 31 | **Gov** | Is this Governing Leg **Sp**? | | Add in the word Yes or No only where leg has a hood attached | **Yes** or **No** |  |  | | |  |  |  | | |  |
|  |  | Having decided which leg is the Governing Leg – you now ad that leg’s Pressure Loss to all and every Common duct leg (ie legs without a Hood attached).  That then gives you the **Index Duct Pressure Loss** …….. which is in effect the **Total System Pressure Loss; “FSp”** (Fan Static Pressure). | | | | | | | | | | | | | |
|  |  | Pressure Loss in Governing Leg | | Value from the leg you said “Yes” to in Row 31 | Pa |  | |  |  | |  | |  |  | |
| 32 |  | Total System Losses **(FSp)** | | Add value of **governing leg (Row 31)** to value of Common Duct(s) section(s) leading to fan plus any common duct up stack (discharge stack) | Pa |  | | | | | | | | | |
|  |  | Most fan manufacturer’s fan selection charts show the relationship between flowrate and FSp. Just occasionally they will show the chart as Fan Total Pressure (FTp) against Flowrate. You need to be able to calculate FTp (just in case).  It’s easy – you simply take the value from Row 32 (**FSp**) and add to it the **Velocity Pressure in the duct out from the fan** (Row 13). That will be the Vp in the duct section leading out from the fan (ie up the discharge duct) | | | | | | | | | | | | | |
|  |  | Fan Total Pressure **(FTp)** | | Add value at Row 32 to the value for the Vp from the fan outlet (Row 13) | Pa |  | | | | | | | | | |
| 33 | **SPh** | **Sp**(hood) | | Rows 9+(13x(17+18)) | Pa |  |  | | |  |  |  | | |  |

**Design Spec for System**

**Flowrate m3/s**

**System Losses (FSp) Pa**

**Fan Total Pressure (FTp) Pa**

***(FTp = FSp + Vp out from Fan)***

**Fan Selected?**

(If more than one fan from a selection of the available Fans/Charts would do the job – chose the one with the greatest efficiency for the duty)