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I affiliated to Sri Mallikarjun, NST Kitten man Judas Icollege konkona. In this video, I will discuss Crystal field stabilization energy of octahedral and tetrahedral complexes. This is a part of discipline specific codes of BS in chemistry. Which is taught in various colleges affiliated to Gowanus City? This brief video includes the introduction to the magnitude of crystal field splitting of tetrahedral and octahedral complexes. Then calculating the crystal field stabilization energy and we would know why crystal field splitting for tetryl complex is less than that of octahedral complex. Also, we would compare the Crystal field stabilization energy of

octahedral and tetrahedral complexes, and then we'll just summarize. This video intends to demonstrate different in the magnitude of crystal field splitting and comprehend the understanding of formation of octahedral and tetrahedral complexes with different metal ions. To understand this, let us first consider 5D orbitals. There are 5D orbitals, namely D, XYZDXZ and DX squared minus Y square and easy square in a free metal ion when ligands are absent. These orbitals are degenerate means they are equal in energy when octahedral field is introduced as this orbitals are oriented in different directions in space like DX, YZ&DXZ orbital are oriented in between the axis while DX squared

minus y ^2 Z square are there on the along the axis while the X ^2 -- Y square and DZ squared. Orbitals are along the axis. When octahedral field is introduced. the ligands approach is along the axis. When this happens, the energy of. Orbitals, which are along the axis will get higher up and the energy of the orbital which are in between the axis will get lowered. Here DXYZ&D, XZ are triply degenerate orbitals so they are called as T2D orbitals in Oct. Idle fade or they are called as T to the set of orbitals in an octahedral field. Similarly, DX squared minus Y square, and. DZ square have equal energy and they are degenerate, so they are called as easy set of orbital in the octahedral field similarly. In the tetrahedral speed,

these orbitals split into different energy. Here in tetrahedral feed the ligands approaches the metal center in between the axis. So there will be again change Indian degeneracy of the orbital so they will split. So here they will split into East and T2 set here E set consists of DX squared minus Y square. Where this orbiters are along the axis. And along the axis, no electrons of the ligands are approaching the metal center, so the energy of this set, ESET will be lower T2 said in a tetrahedral field consists of D XYDYZ&DX red orbitals of equal energy, and since these orbitals are in between the axis and ligands are approaching from inventory in the axis, that energy will be getting higher up.

So we observe a split. In the energy and this split is known as crystal field splitting, so we have crystal field splitting for octahedral complexes, represented as data HO, and we have split it with the tetrahedral field, where the crystal field splitting is expressed in terms of delta T. Here we should also understand that magnitude of crystal field splitting of octahedral complex is shown higher than the magnitude of crystal field splitting caused by tetrahedral field. We can calculate crystal field stabilization energy using this formula for an octahedral field. We can consider the formula crystal field stabilization energy for octahedral field is equal to minus 0.4 into north.

That is number of electrons in T2D orbitals plus 0.6 into number of electrons in EG orbitals and the unit for crystal field stabilization energy of octahedral complexes by this formula is delta, oh. Next we need to find the crystal field stabilization energy for tetrahedral complexes. Then we consider the formula crystal field stabilization energy for tetrahedral complex is equal to minus 0.6 into north. That is, number of electron. In each set of the orbitals plus oh point 4 into number of electrons in T2 set of the orbital and the unit for crystal field stabilization energy, we can consider as delta T. We should understand why Delta T is roughly 4 fourth.

That is the factor we get. Well, we divide 4 by 9, so it is roughly 4 by 9 times then that of delta. Oh that is octahedral field. This is mainly because of two reasons. As we understand, in a tetrahedral field only four ligands are associated with the central metal ion. While there are six ligands approaching the metal center in octahedral field. So we have a ratio of. 4 by 6 so empirically it is two by three. Also we understand the direction of the metal D orbitals does not coincide with the ligand orbitals in tetrahedral field. So. This means that ligands are approaching along the four sides

in the tetrahedral complex.

While ligands are approaching from the six sides in the octahedral complex. So this would also give the factor of. Two by three. So we have two by three into two by three is equal to 4 by 9. So when we need to compare crystal field stabilization energy of tetrahedral complex, we need to express crystal field stabilization energy for tetradic complexes with octahedral complexes for the same electronic confirmation that this deal electronic configuration, we need to have the same unit. So in this formula, crystal field stabilization. Energy for tetrahedral complex is expressed in the unit of Delta, oh, so, crystal field stabilization energy. For title complex expressed in terms of Delta,

oh is equal to four by nine times. Crystal Field stabilization energy for tetrahedral complex, expressed in terms of Delta T and now it's unit is delta OK. This table includes crystal field stabilization energy for tetrahedral and octahedral complexes. Here, electronic confirmation that is D1D2D3 system. With this we can calculate the crystal field stabilization energy for the octahedral and tetrahedral complexes. Here we have only considered the high spin. State because the magnitude of crystal field splitting for the tetrahedral complexes is less. So most of the tetrahedral complexes are high speed in nature. That means the pairing of the electron does not take place

unless all the D orbitals that is. P2G ZZ is first singley occupied. So in case of octahedral field we have also considered only high spin complexes and we have calculated the crystal field stabilization energy. Here Crystal field stabilization energy. We should understand that minus 0.4 implies to the stabilizing the complex by minus 0.4 factor when one electron is there. And in the tetrahedral complexes, this one electron would stabilize by minus 0.6 as we know. The T2G orbitals, or the electrons in T2D orbitals, would stabilize the crystal field. Stabilization energy would be lower so complex will be more stable when the electrons are there in a T2G level and when the easy level the

electron starts getting occupied.

The Crystal Field stabilization

energy decreases.

For tetrahedral complexes,

the electrons in ilevel that each set

of orbital would stabilize the complex,

while the electrons in T2 level would

destabilize the complex and the

there will be a decrease in crystal

field stabilization energy when

there are electrons in T2 orbitals.

So here if you observe a trend, it is.

From D1 to D10,

system crystal field stabilization

energy increases,

then decreases,

then again increases and then

decreases similar trend if you observe.

Similar trends you observe for

tetrahedral complexes also now

when we compare Crystal field

stabilization energy for delta.

Oh,

that is for the octahedral complex and crystal field stabilization energy for tetrahedral complex. We need to express in terms of the same unit. So in the last column we have expressed crystal field stabilization energy in terms of delta over using the formula previously discussed. In this last column we have. Use previous formula to calculate the crystal field stabilization energy. And which is expressed in delta. Oh. So now we can compare this graphically. Also this can be represented and we can understand the significance of crystal field stabilization energy for octahedral and tetrahedral complex. Here. With the number of D electrons,

the crystal field stabilization energy is plotted, so we have a double hump curve observed from crystal field stabilization energy of octahedral complex and tetrahedral complex. Express in terms of Delta O. Although we observe a double hump curve and the trend is similar, the peak position for the Crystal field stabilization energy is different. It is observed the crystal field stabilization energy for two types of complexes are insignificant for D0D5 and D10 because there is symmetrical electronic distribution. Here we should note that difference between. The Crystal Field stabilization energy for tetrahedral and octahedral complex. Is not very much for D1 and D2 system and D6 and D7 system while D3 system there

is a large amount of difference between the crystal field stabilization energy. And for also further D4 system we can see these things and also for D8 system and D9 system there is a large difference between the crystal field stabilization energy of octahedral and tetrahedral complex. So we can conclude from this figure the octahedral complex would be more favored compared to the tetrahedral complexes, because there will be higher amount of crystal field stabilization energy. However, when there are bulky ligands, are there? They can cause the overcrowding in the molecule and the tetrahedral structure may be preferred in those cases. This could happen with strong field ligands specially. We now know why.

The crystal field splitting for tetrahedral complex is. Less that is 4 by 9 times that of crystal for speeding of octahedral complexes. This is mainly because of the number of electrons. This is mainly because number of ligands and the orientation of D orbitals. The Crystal Field stabilization energy is insignificant for D0D5 and D10 system because the electronic configuration or electronic distribution is symmetrical in EG and T2G orbitals. We could expect the tetrahedral structures for the electronic configuration. When the ligands are bulky. In case of D0D2D5D7 and D10 system, because the crystal field stabilization energy, the difference between the octahedral complex and dettra

idle complex is less than 0.27.

One can read more in detail

about this concept in concise

inorganic chemistry generally,

which is available in most

of the college libraries,

and it is also a reference

book described in the syllabus.

Thank you.

Happy learning.