***Sheet no : 2***

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***today we gonna go into a little bit more details in physics and AC production and second lecture we will study interaction with matter.***

 ***What is the X-ray tube?#***

***It is a vacuum glass inclusion that has some components into it .***

***# Why glass ?***

***Because glass has these properties :***

***1-electricle isolator***

***2- it maintain the vacuum***

***3-X-ray transparent***

***4- has high melting point (the process of X-ray production transferred by 99% as heat ) , so that's mean heat is the main major problem in any X-ray machine .***

 ***Components of X-ray tube :#***

***1-cathode ( filament ; wire ) : set on focusing cup , the filament made of material that has these properties :***

***a- high electrical conductivity (to increase the heat to create electrons ; so they can transfer from one place to another .***

***b- it must be high vapor pressure ( if it low ; it will evaporate then we will lose 4000 DJ) ; we need to maintain it as long as time .***

***2- anode: in another side.***

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***## Electrons come out from the filament (cathode) so the electricity (electrons) will pass and there is a friction comes from resistant ; this friction increase heat .(it looks like that the outer shell electrons are boiling , actually they take energy so they can move from its orbit this is called thermionic emission.***

 ***#Thermoionic emission : this name comes from thermo (heat), ionic (electron escape from its atom ,emission (because it comes from cathode material )***

***What is the focusing cup ??***

***We have a group of electrons come from the filament and the electron have negative charge so it will be repulsion so we must put a positive charge to keep it in line (to preserve it from scattering because these electrons cost money and time ; if it take a lot of time , the pts will move so the quality of image will be bad and disturbing )***

***So we need focusing cup to focus electrons by trying to bring disparate electrons together .***

***As conclusion :***

***Electricity pass through cathode then heat will increase and produce electrons , these electrons hit the anode and produce***

 ***X-ray by “Bremsstrahlung or “Characteristic” Radiation***

 ***Electrons heat Electricity pass through cathode***

***Target ( anode) X-ray production .***

***The properties of anode material : #***

***1-high electron conductivity***

***2-high melting point***

***3- high atomic number***

***“Bremsstrahlung: is a statically event , when electron increase the chance to repulsion , new electrons increase as well .***

***High atomic number mean higher electron number, so if we have material with high atomic number it will be more efficient .***

***“Bremsstrahlung: the electron comes to atom (interact not penetrate ) , it will be repulsion with a moving electron of atom so the kinetic energy will change and the difference in energy is transferred as heat (major) ,the rest as X-ray .***

***“Characteristic” Radiation: electron comes in atom and locked out .. it will create as empty space in inner shell electron , so the electron in outer shell will replace the empty space ( instability) so difference in energy will happen ,, energy goes as heat and X-ray .***

***\* most of X-ray production comes from Bremsstrahlung ..***

***## line focus principle :***

***As we know heat is the major problem in X-ray tube .. so how engineer handle this heat and still get good image ?***

 ***We need high efficiency and high image quality , so we have to balance these two things.***

***# idea of line focus principle : if I focus heat or any energy on small area we will be more effective than larger area that’s mean heat the same point , other wise it will melt ,so we need to expand the target point … how ??***

***There is some thing called special resolution … is one of the image quality function and it means that when we take image to any anatomical structure to see the small structure inside that structure and to identify them as tooth part ( same thing as Google earth ) it start large and you zoom in until you see small details ) .***

***# one of physical requirement of decent resolution is that : the area ( focus spot) which electrons hit anode must be small .***

***Now there is discrepancy which is ….. one area must be small to get a good image quality .. on other side area must be large to get a good dissipation of heat .***

***,, how engineering solve this problem .. very smart idea >>***

***1- I need good heat dissipation when I see from cathode .. so engineer put anode in way not facing cathode exactly ( there is an angle 50 degree ) .***

 ***2- they make isolation every where to see focal spot at this angle in which the window of tube that emit X-ray must be in one side , so the central ray is small for a better image quality .***

***## so when you see from cathode .. you see that electrons spread on large area that means it dissipate heat to preserve the X-ray tube .. As film you see small area ... that means you get a good image quality ,,,, this is called line focus principle ( it is just an engineering trick .. you don’t really change the actual shape and style of that area ) .***

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***# there are factors that change the shape and size of the area .***

***Imaging if the cathode is standing ,it will still hit at the same area overing and overing ..***

***How about if it round and wraps ?***

***At the end of we will use all pole instead of using 2cm X I cm .***

***Because when it wraps .. the hit area have a time to cool and have another chance in a second roll … so that’s another trick , and that’s a technique called rotating anode .***

***\* each fancy trick occur in machine , that’s mean this machine has more efficiency , can see more pts , can still on for longer time .. so can do more technique ( even difficult ) and also it can do more exposure time .***

***Then by definition , it will become more expensive .***

***So alternating current is smart idea toward dissipate heat .***

 ***# kilo voltage (which is a normal voltage that come from the wall) : is low voltage , high amperage . and we need another way around it >> so it must be inside any X-ray machine things that modify the voltage and amperage of the output which come from the wall ..***

***That’s mean we don’t use electricity which come from the wall as it self , it need to change .***

***# Amperage : is the number of electrons that pass through a certain point in a seconds , it just a rate of power flow .. measured by amperage or milli amperage .***

***# voltage : is about of energy of these electrons .***

***# when we change a milli amperage , we change the number of electrons that come into the wire .. ,,,.. when we change kilo voltage , we change these photons***

***... so these will affect the image quality .***

***# because the difference between energy that come from the wall and the energy which machine need , we have things we call it transformers .***

***# there are things need arising , so we need step up transformers ..***

***And there are things need lowering , so we use step down transformers ..***

***# in general the idea is : the electricity that come from the main supply is not enough , it need to transform into the proper kilo voltage and the proper amperage .***

***#there are two circuits in any X-ray tube :***

***\*\* The first one ( small one) : electricity which should pass through the wire (cathode ; filament) as we said before to heat the wire .***

***To get a high resistant and a arise the degree of temperature , I need high number of electrons ( high milli amperage) for better result .***

***\*\* The second one (large one) : electricity which should pass between cathode and anode .***

 ***then when electron get out from cathode , so I have to impose it to go to another place ( I need energy) and that’s why electricity between cathode and anode has a high voltage , also that’s why using step up in one place and step down in another place.***

***# in summary we have different type of electricity ( depend on energy and electrons ) in 2 circuits :***

|  |  |
| --- | --- |
| ***Electricity of large circuit*** | ***Electricity of small circuit*** |
| ***Has a high voltage*** | ***Has a high milli amperage*** |

***\* electricity should go from cathode to anode not opposite to take electrons from the filament .***

***\* we call normal electricity .. AC ( alternating current ).***

***## in electromagnetic theory : energy forms are like waves .. these waves gets up and down .. when wave gets up ,the electron moves in correct way .. . when wave gets down ,the electron moves in overturned ; so no X-ray production .. so it take a longer time and we don’t want to let the pts wait for long time .***

***So one scientist suggested to omit peak varies and make all waves peak .***

***.. . another scientists say that peaks start arising then lowering to zero , so it isn’t efficient enough (they don’t want to lose even milli seconds) …. So what they do ??***

***They let it to arise , but they don’t give it a chance to become more down ( I take the peak and try to maintain peak as much as I can ).***

***\*\* we see numbers which are KV (kilo volt) rebel ( means : how much I allow wave to gat up and down ) :***

***If I allow wave all the way to recover this is 100 % kv rebel ;***

***But if I allow it less than 100% , that’s better .***

 ***So as the number decrease we talk about more sophisticated technology , more efficient machine and more expensive as well .***

***We have a timer in machine ; the time of exposure is one of the important for image quality .***

***there are facrors need to think .. if I can change it to change my image quality or if it is a part of anatomy of life so I need just to understand it and live with it ..***

***## factors affecting the X-ray :-***

***1-current: milli amperage (how many number of electrons ).***

***2-time : it is about the amount ( I will get more amount if I let it 10 min rather than 5 min )***

***,, so current and time are basically same thing ..***

***3-potentil ( kilo voltage) :we talk about energy***

***4-distance : nearby or far way***

***5-target material***

***6-filtartion***

***7-econmation***

***## lets talk about time , voltage , amperage :***

***If I give more electrons I am getting out more X-ray those X-rays are gonna penetrate that object more so I get a darker image.***

***## Dr show us chart and we noticed in it that : the amount of photons at every single energy just double , not change in energy , peaks not moved either right or left side ..***

 ***the difference was 5 photons , they become 10 photons .. because I double the current or time (it's the same ) .***

***\*too much MA ( milli amperage) or too much time ; the image will be too dark .***

***\* too little MA or short time ; the image will be too light .***

***#when we talk about voltage ; it is the same with one extra addition :***

***If I increase energy it will increase the penetration; then the image will be dark .. No difference , but here when I change energy it self I don’t change only the number of photons , I also change the concept of contrast .***

***# contrast resolution : the ability to see material in different density.***

***\* as we can see more material with smaller different density ; it will be higher contrast good image quality .***

***#but there is a problem (when all become high ; it become no varies to see and differentiate between enamel and dentin ( it become close together).***

***#usually if I have a problem with darker or lighter image ; I would play with MA or with time ( because its easier to calculate it as we said ) .. we don’t play with contrast because it difficult to control it .***

Successful people keep monving .

They make mistakes,

but they don’t quit :))