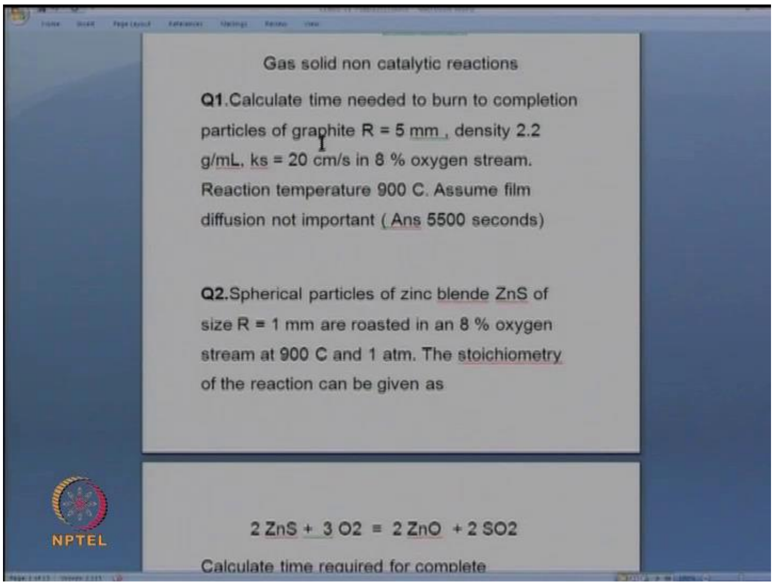
Advance Chemical Reaction on Engineering
Prof. H.S.Shankar
Department of Chemical Engineering
Indian Institute of Technology, Bombay

Lecture – 35
Introduction to Environmental Reactions

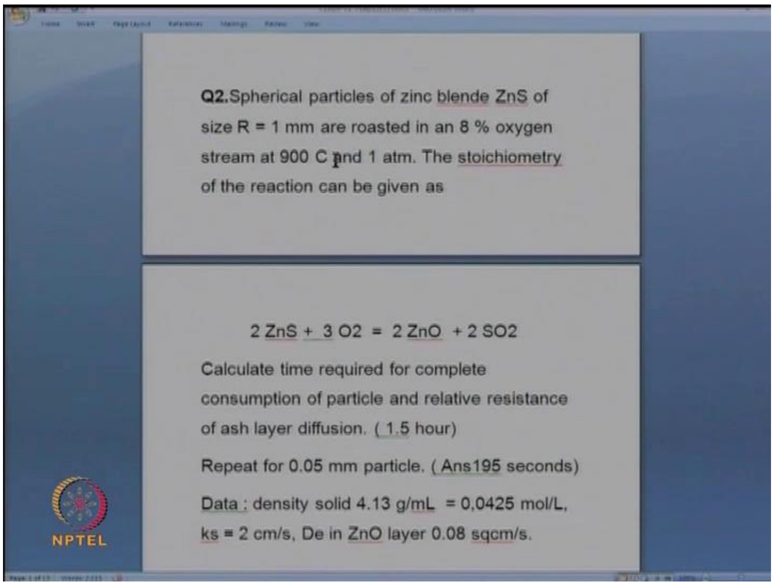
We are looking at practice problems on gas solid reactions. The object of these problems is to demonstrate you the order of magnitude of this numbers.

(Refer Slide Time: 00:38)

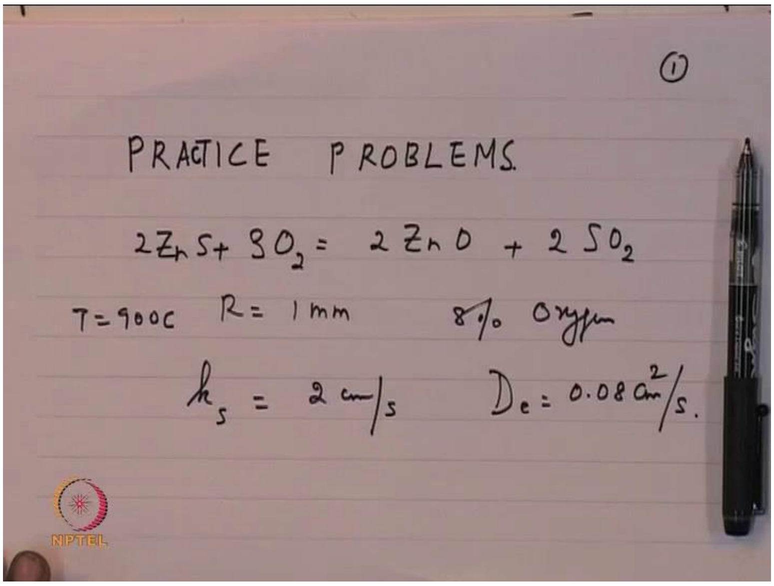


That is whether it is reaction velocity constant, whether it is external diffusion coefficient or the internal diffusion coefficient etcetera. So, all this numbers is what is the; prime object of these 5 or 6 exercises so that, in a given problem, we can understand how important the existences from the different controlling that ethives. Quickly, the first 1 is about combustion. And then it gives is some numbers regarding the reaction velocity and the temperature and so on. Let us quickly calculate, what is the time let me see whether I have done this.

(Refer Slide Time: 01:12)



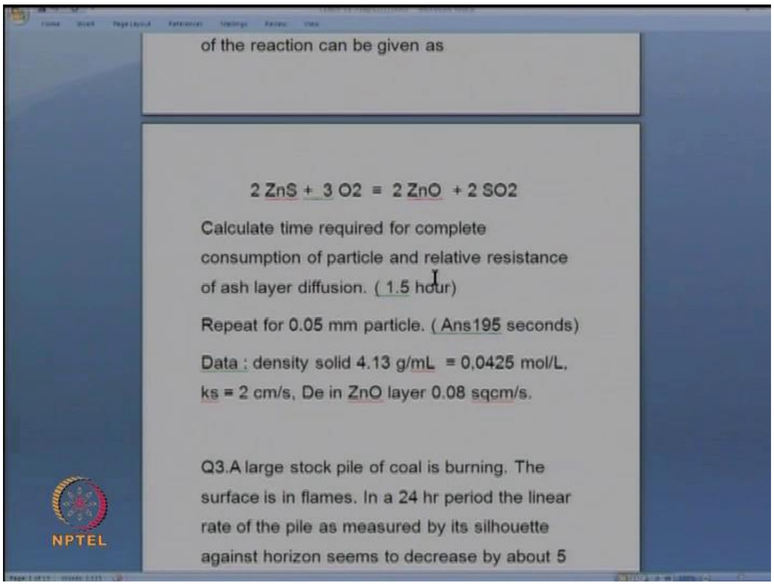
(Refer Slide Time: 01:15)



Here we have twice Z n S plus thrice O 2 twice Z n O plus twice S O. Size of the practical is 1 mm, it is roasted in 8 percent oxygen. Let us temperature is 900C. Data is given for time required for complete consumption, we have diffusion co efficient, the data is given here k s is given has twice centimeter per second D e is given as 0.08 centimeter square per second.

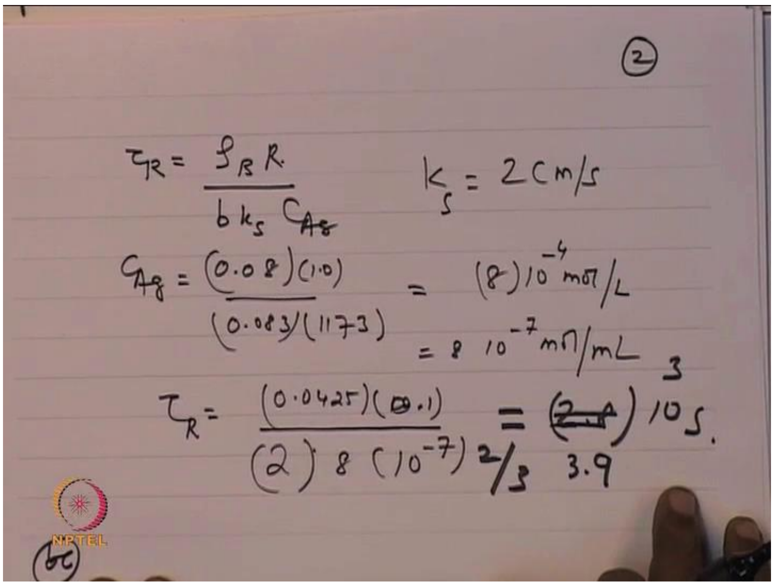
Now the context splice recognize that, this is 1 mm practical and zinc sulfide is roasted around the world in fluid has beds. So, you have a fairly small size of particle. That is why calculation are first small size of particle, as zinc sulfide is converted zinc oxide, there is a anti reacted core. Therefore, both the reaction; reaction velocity as well as diffusion coefficient in the product layer are important.

(Refer Slide Time: 02:40)



Notice that the external diffusion is not very important in this problem because, of the fluid has bed, they that is lot of external mass transfer is high there, for that point is not taken into account.

(Refer Slide Time: 02:49)

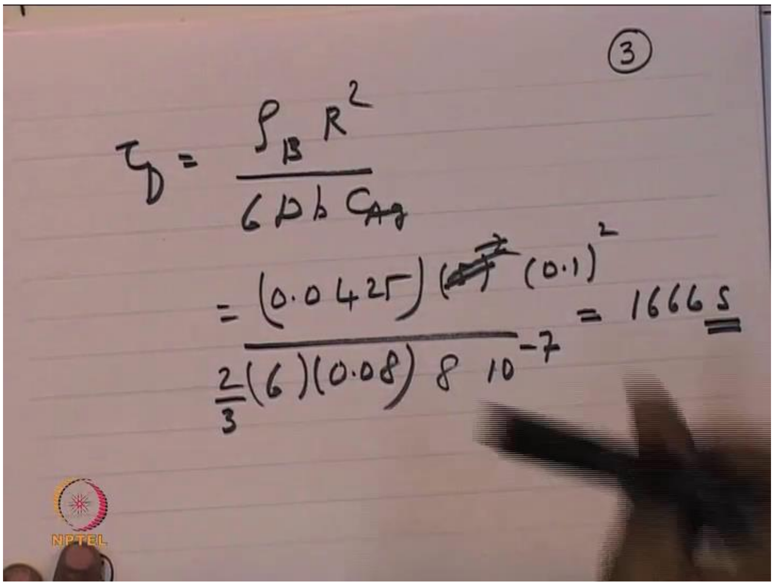


Let us quickly calculate tau R you know this divided by b times k s times a gand. What we

C A g? 8 percent oxygen p by R t 0.083. Temperature is how much what is temperature? 900. So, is 1173. So, that comes out to b that p by r t is an atmosphere 8 10 minus 4 mole per liter or 8 10 minus 7 mole per ml. So, now, we can substitute. So, tau reaction equal to what is the density is 0.0425, the size is 1 mm, 1 mm means, 0.1centimeters, k s is 2 centimeters same to be it is for second 2and C A g is 8 10 minus 7.

So, that turns out to be to be; b is missing correct, b here is 2 by 3 is 2 by 3 2 by 3. Now no a gas plus b b solid is 2 by 3 is it2 by 3. So, it comes out to be 2.8 10 to the power of 3 seconds, is tell me whether this correct 2.8 10 to the power of 3 seconds, we all get this 2.8. So, what is it? 3.9 is it? You all get this 3.9 minus 10 to the power of shall I say it is 3.98 10 to the power of 3. Fine let us go of further.

(Refer Slide Time: 05:08)

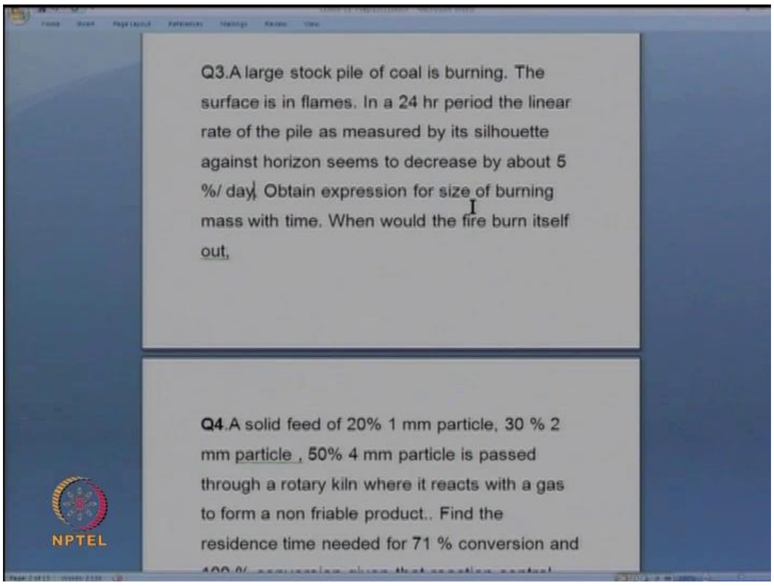


Then we have tau D is row B R squared by 6 b times C A g. There is put all the numbers 0.0425, R squared is 5 squared 6 diffusion coefficient is 0.08. What else? C A g; C A g is 8 10 minus 7 is it. So, R is 1 mm is it 0.1. Now b, have a taken b into account? You have not is 2 by 3. Tel me what is the answer? 1 6 6; something like this. Now, please recognize that, the reaction time where time for complete consumption, the reaction control is 3900. And time for complete consumption and that diffusion control is 1600. It is in instants; why the reaction since to behave in more resistance, compact to the diffusion through product layer. The reason is size of the particle is small, that is why you have not seeing that effects so much. If it is the bigger particle, you would a see that effect.

Learning aspect here is that, a new dealing with small particles, you in find reaction control that resistant is important. That is the important point that you have clear across. If a seen a fluid bed this solids and the gas solid is moving rapidly, gas is therefore the hydrodynamic effects on this solid surface, is such that you know that film thickness is very small. So, it is not very important because it is a fluid bed.

Now, look at this is a have taken this from11 s period, you always gives nice problems.

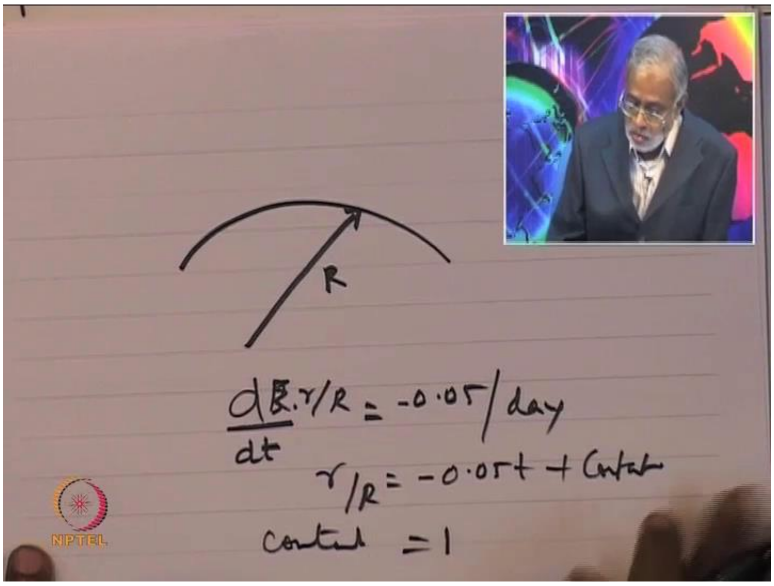
(Refer Slide Time: 07:16)



Like this. So, there is stock fair which is burning, with says and then surface is in flames and then you are looking at it from a great distance because, you cannot go on near it because is burning huge quantity of coal with burning. So, he will look at from a great distance correct. So, you will try to understand what is happening. You say's the linear rate of the pile as measured by its silhouette.

Silhouette means the shape of the burning flame. And it seems to be decreasing at the rate of 5 percent per. The rate of 5 percent, it is not mentioned per hour, minutes per hour. 5 percent per hour will be, I do not know not mentioned that, but, is because I might have missed it that is all. It is say's 5 percent per day, its 5 percent per day. Now how do you this? 5 Percent per day. So let us quickly understand this.

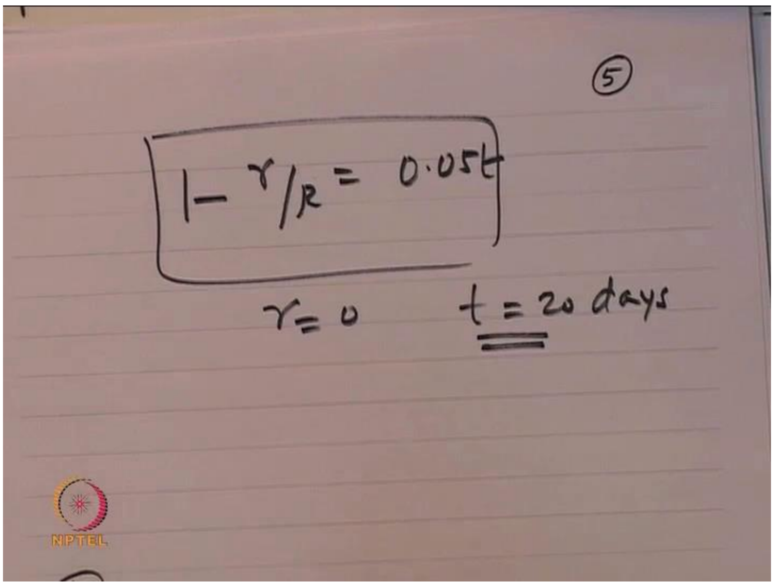
(Refer Slide Time: 08:15)



You have this flame and this is what we are seeing, this is decreasing at the rate of, it is percent r by R is 0.5 per day, it is what is given. You understand that. Now it is says update in expression was size in the burning mass with time. So, we can integrate this. So, it is r by R equal to 0.05 plus a constant correct. That clear at t is equal to 0, size is a left inside is 1. So, it is minus.

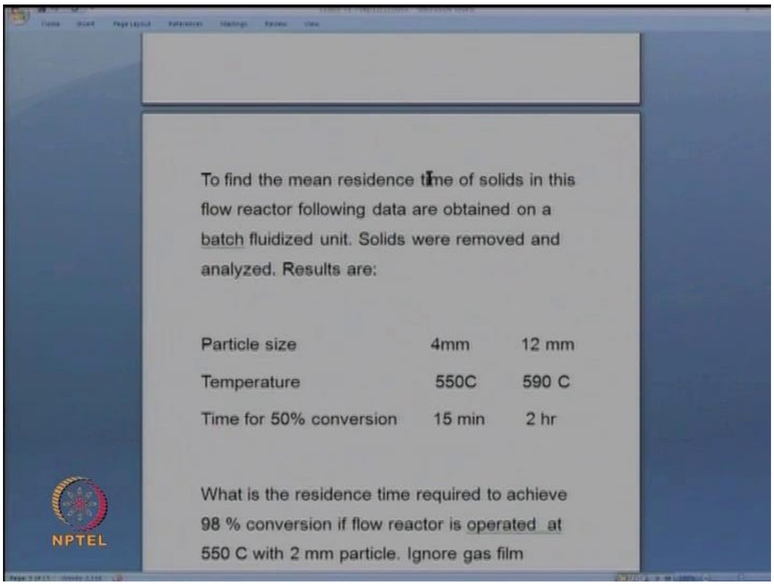
So, at t equal to 0 R equal to z a left an side is 1. So, the constant is 1. So, it becomes constant equal to 1. So, what is the solution?

(Refer Slide Time: 09:14)



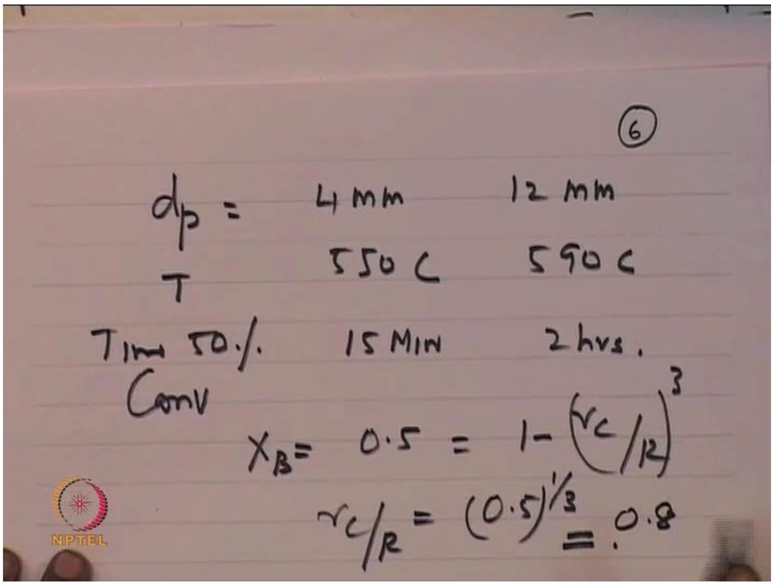
1minus r by R equal to 0.05, it is all right. How long it is take for this to burn out? How long would you take for into burned out how long of how many days? When does r become equal to 0? So t equal to 20; 20 days. what is what processor11 's will is trying to convey that, when you have a burning mass, you have to actually judge all this things from s distance is a, this is this 1 simple way of judging it from a distance. You cannot go a near because, it is burning.

(Refer Slide Time: 09:56)



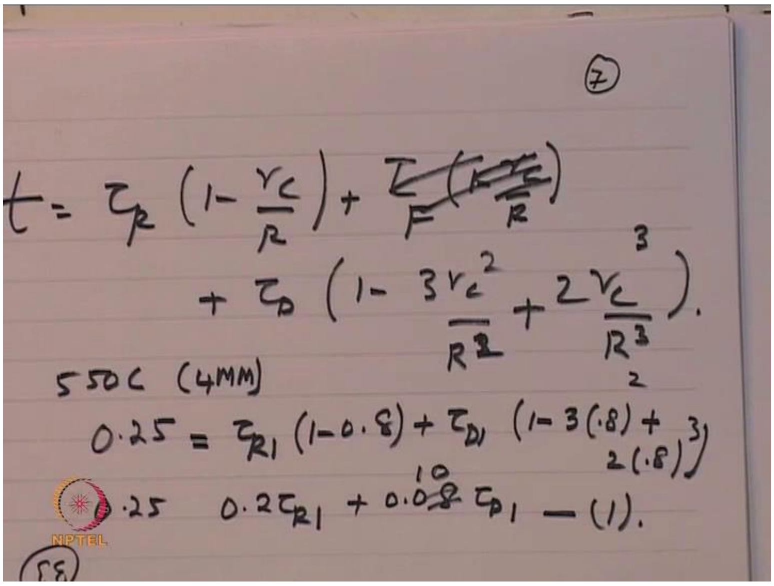
See, we did this yesterday but have not satisfied with a kind of answers you gave me. I like with do it again that is quickly run through this.

(Refer Slide Time: 10:10)



So, this is particle size d p 4 mm and 12 mm and then temperature 550C and 590C. Time for 50 percent conversion that is given as 15 mints and 2 hours. Now if conversion is 0.5, we know that this is equal to 1 minus of r c by R whole cube correct. This is we no; yes or no. Therefore r c by R equal to 0.5 it is the power of 1 by 3, whatever that is, tell me what is it? 0.8.

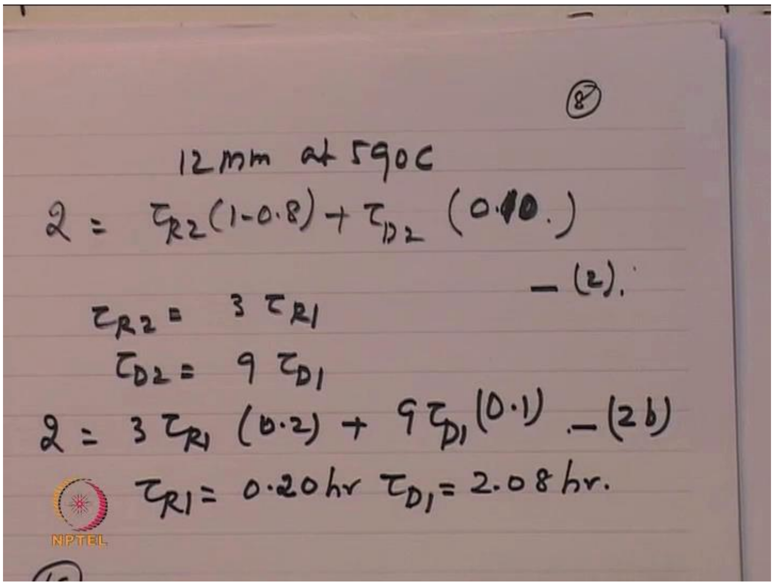
(Refer Slide Time: 11:04)



We know from this, I just said this down 1 minus of r c by R plus tow F 1 minus of what is it? r c by R, it is not important because, in this case is not important; tow D 1 minus of 3 r c squared by R q plus twice r. Here film in this particular case, it is mentioned clearly from where ignore film resistance, mentions here. And generally what will happened is that, many of the commercial excise of that we do; the resist external diffusion may not be very important.

Most case will because, velocity is a quit large in so on. What is given is tow 0.25, let me say this is for the case of 550C corresponding to 4 mm particle this is 4 mm particle. We have tow or 1 1minus of 0.8 plus tow D 1 1 minus of 3 times 0.8 squared plus 2 times 0.8 cube. This is what we have. So, this simplifies is point 2 tow or 1 plus 0.08 this is not I get. Please tell me whether this is right; equal to 0.25. So, this is equation 1 will got it right 0.2 and this is; this 0.08 is correct this is what 10 is all right. Now this is for 4 mm particle. Then we will do for 12 mm particle.

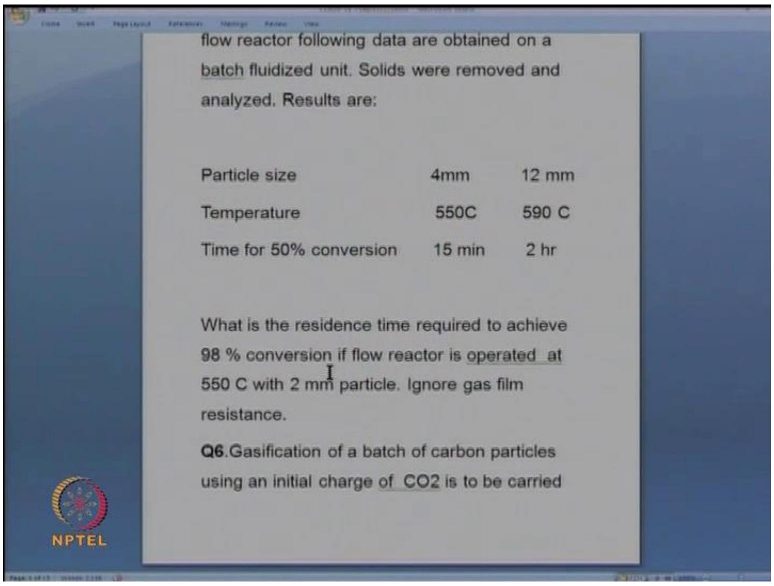
(Refer Slide Time: 13:10)



So, at this is at 590C. So, what I get is 2 equal to tow R 2 1 minus of 0.8 and then tow D 2 are just put all the numbers, this is what I get. r c by R is pay substitute 0.1 you are saying I thing you are 0.1 you are saying is 0.1. This is equation 2. tow R 2 is thrice tow R 1, tow D 2 is 9 times tow D 1. Now we can substitute here, we can substitute in term mean equation number 2. I will replace is a 2 equal to tow R 2 is 3 times tow R 1 1minus 0.2 plus tau D 2 is 9 tow D 1 times 0.1. So, this is equation, I can call it equation 2 b are something like that.

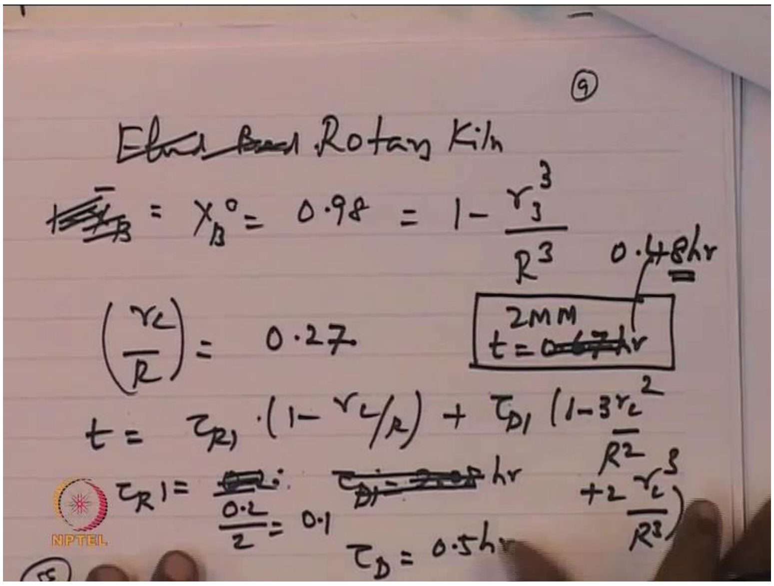
So, this 3 equations can you please solve and then tell me the values of tau R 1 and tau D 1 please 0 point, is that clear what we say quickly solve in tell me the results. Please solve for 1 and 2 and tau R 1 equal to 0.8, tau D 1 2.08. Let us go for that now.

(Refer Slide Time: 15:02)



Now the question is the question here is; what is the residence time required to achieve 9 in a flow reactor operated at 550C. When he say flow react, he means CSTR, we are not said the explicitly, means this is what I wanted to dry attention is a this explicitly said mean, flow reactor could mean a rotary kill, why it is a flock flow which means; you will with they answer directly a news this single particles results. If it is a c s t time, if it is fluid bad then, will have to integrate appropriately, thus results you already done in class. So, let do this for the case fluid bed.

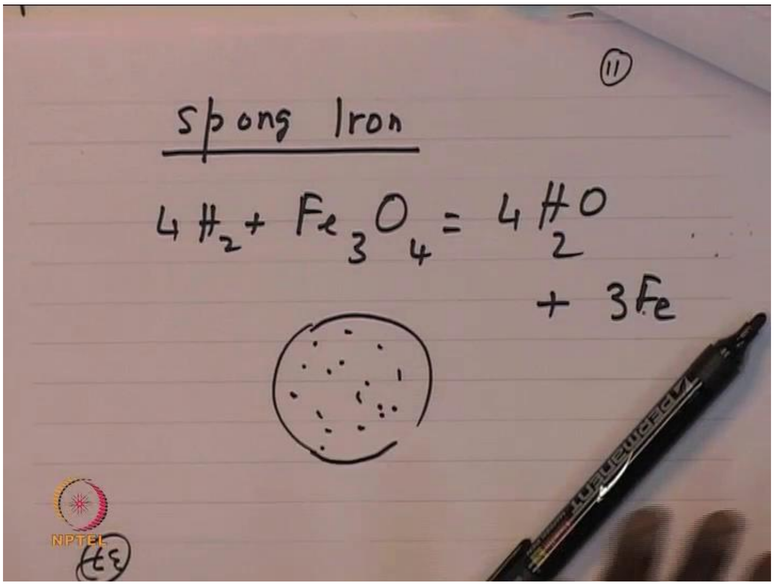
(Refer Slide Time: 15:48)



A fluid bed where, or 1 minus the X B is known to as 1 minus X B bar equal to, but, fluid bed means, we cannot do it for a fluid bed, note; we do it only for a rotary kill because, fluid bed means more complicated. So, rotary kill, where he can use the single pealed the results directly. So, you have 98 percent. So, we X B equal to 0.98. Therefore equal to 1 minus of r c q by R q. So, what is a r c by r? Is 0.8 what is a r c by R? 0.98 0.27 all right.

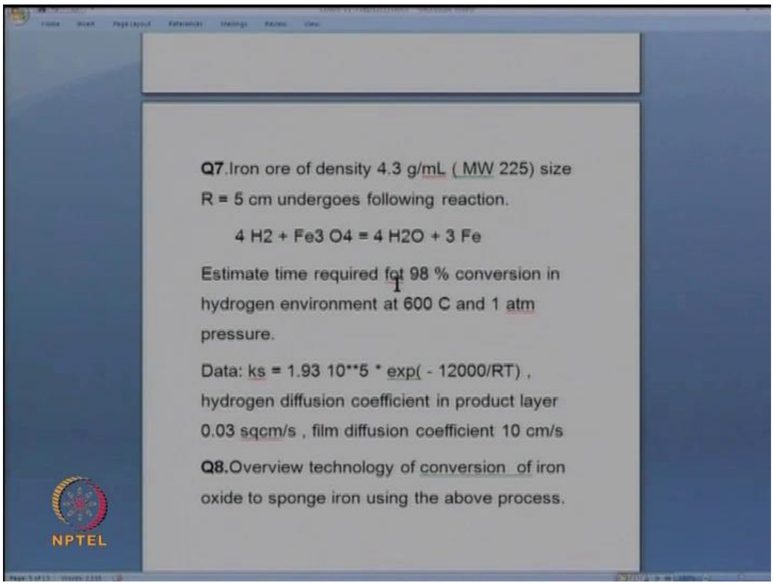
So, now, what is the flow 550C there for t equal to tau R 1 times 1 minus r c by R plus tau D 1 1minus of 3 r c squared by R square plus 2 r c q by R q. Now tau R 1 is non, tau r tau D 1 is non, you can substitute in tell me the result now. r c by R is 0.27, put all the numbers and tell me results. tau R 1 equal to 0.2, tau D 1 equal 2.08. Particle size is what? Size 2 mm correct 2 mm. So, tau R 1 becomes half of that correct. So, becomes; 0.2 becomes 0.1. So, it is 0.2 divided by 2 is 0.1. And tau D 1? tau D 1 is divided by 4 it is 0.5 hour's. So, you put this numbers and give me the result please. So, what is time t equal to? So, let me summer ice here; 2 mm particle t equal to 0.67 hour's. Let us go for that, let's look at this is 0.48.

(Refer Slide Time: 18:12)



Spong iron; see all of you might know about this. 4 H 2 F e 3 O 4 4 H 2 O plus 3 F e. Now see this particular reaction is a blast fairness is the well known technology for a very long time. But, blast fairness economics is not very suitable for small scale production.

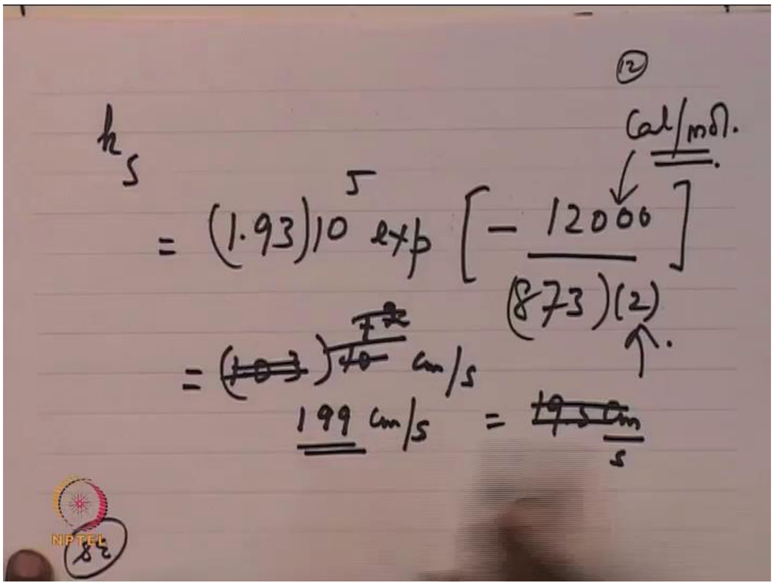
(Refer Slide Time: 08:48)



So, sponge iron is considered a very suitable technology for smaller scales of production. The last numbers of here very large numbers of sponge a n a plans have come off in a particularly in the eastern area, you know believed or killed off in Orissa area. And what they do here is; hydrogen is reaction e d to the oxide to give you iron and water. What happens is that, because it is a solid and then hydrogen reaction said by their when you get your product, the product looks very pores, when you look at the product you will find there is looks very pores because, hydrogen has g 1inside in postures come out, therefore, it looks very pores. That is why it is called s sponge iron, it looks like a sponge is does not came.

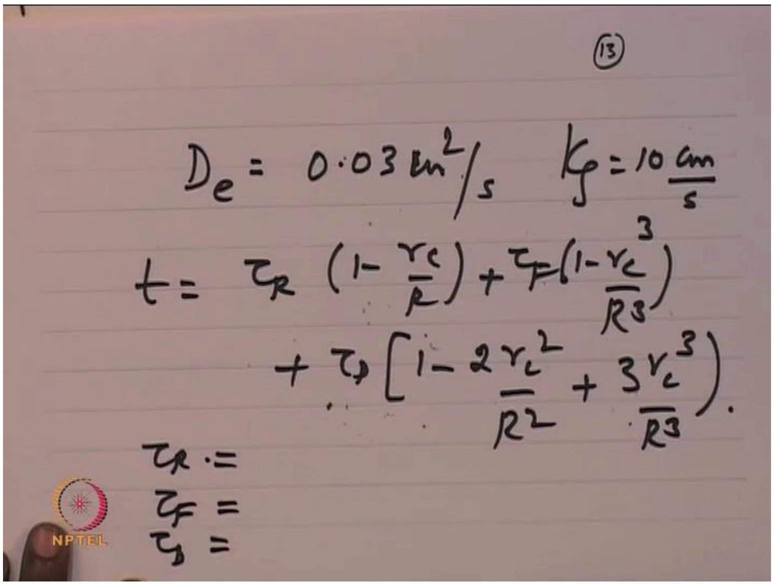
Now this so once again hydrogen diffusing into ferric oxide. Numbers are given and it is important to appreciate that, once again that way it is reaction velocity and diffusion coefficient the product layer which are important. They external diffusion is not all that important. But, he is given a number he can seen here it given a number. So, when you do the calculation you will realize; what is the relative importance of all these resistance. Let us quickly calculate. Let us calculate this numbers quickly.

(Refer Slide Time: 20:00)



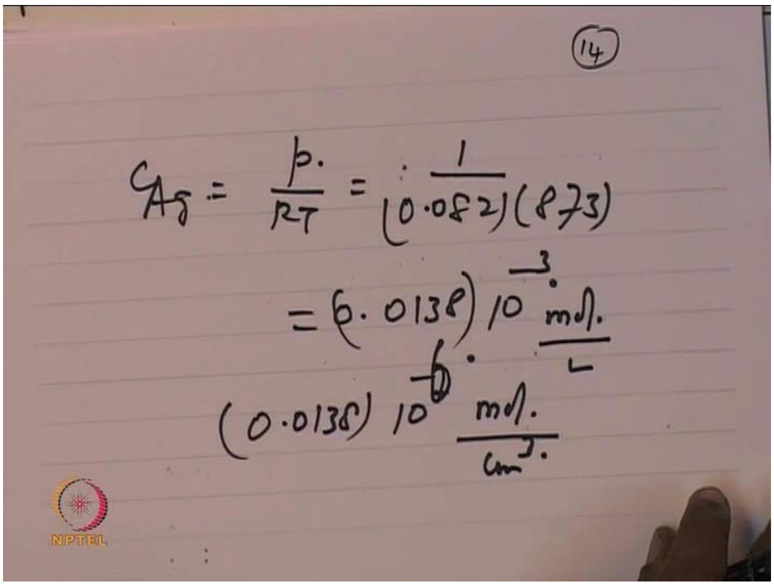
You have a k s is what 1.93 10 ratio of borrow off 5 exponential minus 12000 divided by what is the temperature is 600; so 873 r t r is r is 2. It is sure the unit have to be properly matched. So, it is 1.03 is what I get centimeter per second 1.03 where 10 into borrow of plus 2 what I get or it is what? 19.3 centimeter per second it is what I. You have to substitute, you can recessive carve would have for 12000, 873 that is temperature are gas constant because, this number is generally in calories per more, which it is not mentioned, it is not mentioned. So, it is in calories per mole, that is why have taken 2 the units of calories per mole. So, this would be, what should it be? 199; k s. 1 decimal seems to be not correct 12000 divided by 873 multiplied by 2, is it 19.9? this correct is it? Yes let us go forward.

(Refer Slide Time: 21:47)



Now, D e what is a D e? D e is 0.03 centimeter square per second and kg is 10 centimeter per second. So, t equal to tau R 1 minus of r c by R plus tau F 1 minus of r c q by R q plus tau D 1 minus of twice r c squared by R square raise r c q by R q. So, tau R tau F and tau D, you have to calculate, let me write tau r; C A g I am calculating a p by R T hydrogen.

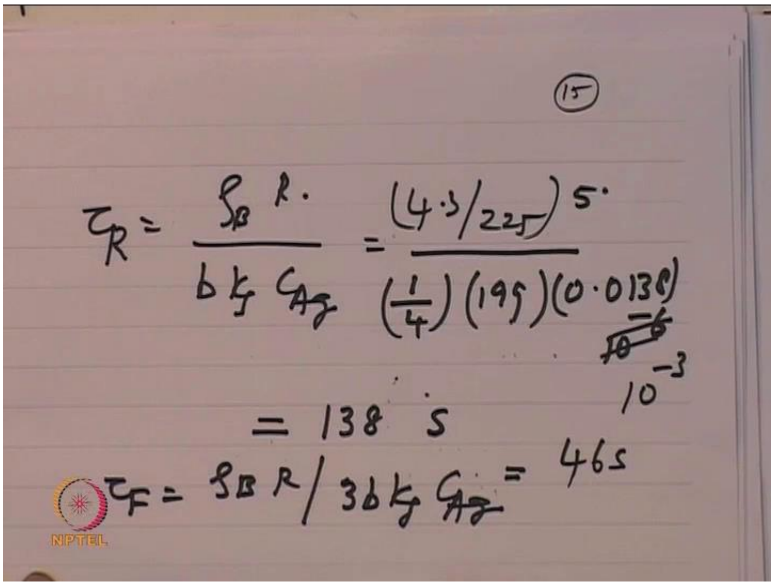
(Refer Slide Time: 22:40)



So, is 1 divided by 0.082 multiplied by 873 it is correct? 873. I get this is 0.0138 10minus

3 mole per liter or 0.0138 10 minus 7 mole per centimeter cube. C A g minus 10 minus 3 10 minus is it all right. So, let us just calculate tau r all the number.

(Refer Slide Time: 23:34)



Let us calculate tau R equal to row B R. What is the value of B here? B is 1 by 4. And density is how much? 4.3 divided by 225, that is density, particle size is 5 centimeters and B is 1 by 4, k s is 199 that what you said and then, C A g is 0.0138 10 minus 6. C A g calculation wrong is it? 082 r t, p by r t pure hydrogen, is this number all right? Shall you go forward? 0.01 per liter therefore per centime q the average you can manage the 6.

So, tell me what is this time for reaction? Time reaction what is this? What is this number? that is the problem, what is the problem? This C A g number is right or wrong?

Student: Right

See is right my friend is a right. Now it is 0.0138 10 minus 3.

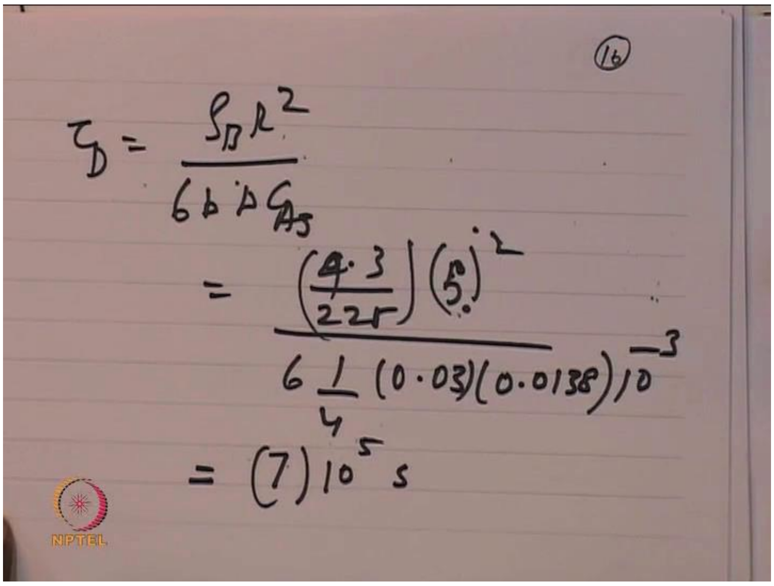
Thank you very much, thank you very much.

So, this is correctly this is 10 minus 3. Now what is tau R? 1 3? 138 seconds. Very good, tau F equal to, What is tau F? 46 seconds, anybody else?46 seconds is right or wrong?. So, difficult about doing this row B is given, R is given, B is 1 by 4, C A g is 10. 46 is right?

Student: Yes sir.

Very good thank you.

(Refer Slide Time: 26:26)



tau D equal to row B R squared 6 b D times C A g, row b is 4.3 by 225 R squared which is 5 squared 6 1 by 4, diffusion coefficient is 0.03and what else? C A g 0.0138 10minus 3. So, what is the answer? 10 minus 3 is here, what time for complete consumption? How much is that rough estimate I will make. 10 minus 4 10 minus 7, tau D is will finished, will go that tau F. What is tau D? do this calculation and tell me quickly. What is that? 7 10 raise to 5 seconds. Is it correct?

Student: Yes.

Very good. Now somebody tau F is wrong.

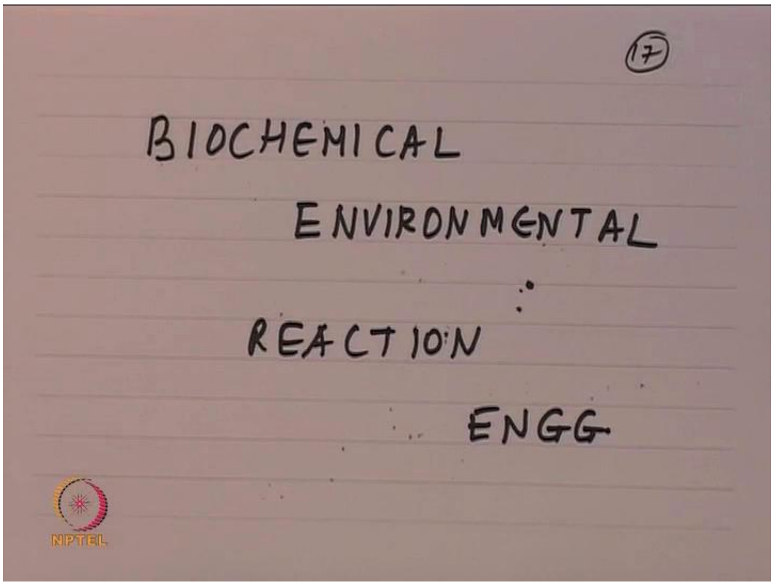
Student: Yes.

Somebody say it is 923.

Student: Yes.

Now it means that, now see now the moral of the story is that, we now have, we knew have product layer diffusion; that is the most important resistance. With an oxide, that is the very important resistance and therefore your reaction times are large, therefore you have to have a large equipment to be able to take care of all right. So, with this, we have gone through gas solid. So, we have an idea of the relative importance of all the resistances and then we conclude; the whenever we have a product layer, the product layer will be an important resistance. So, that finishes what I want to do in gas solid.

(Refer Slide Time: 28:41)



So, today onwards you will look at biological process. So, biochemical and environmental, this is what we want to do; biochemical and environmental. Now the context, all of us know the context or environment globally is in brachiated. And you want to understand the reactions so that, we will designer's systems better and so on. So, let me take some examples to illustration.

(Refer Slide Time: 29:24)

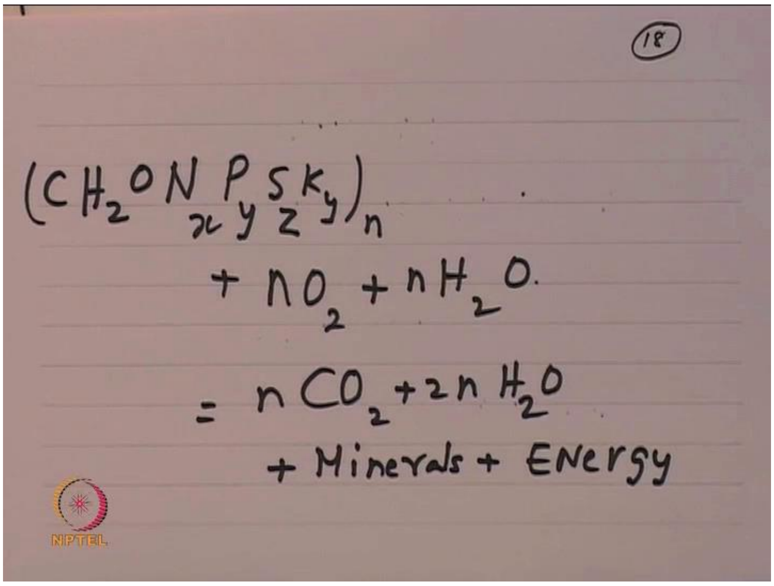
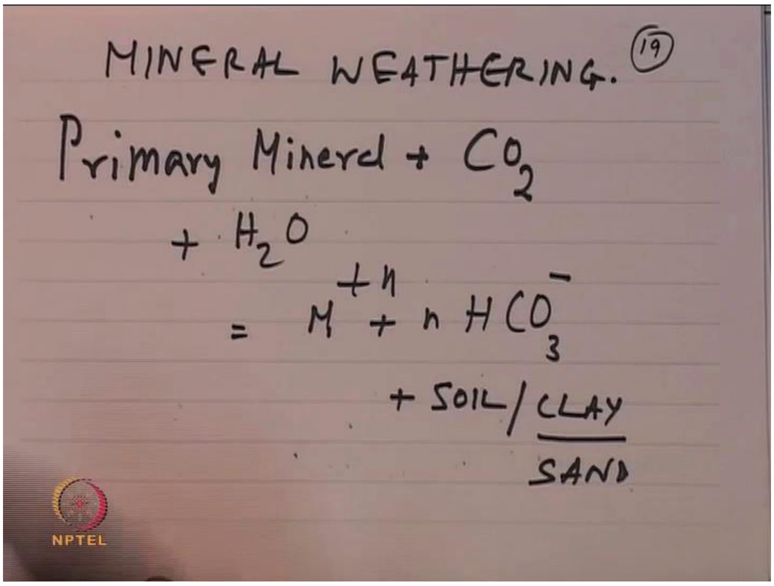


Illustration number 1: So, what is this reaction? You will have carbon, hydrogen, oxygen, nitrogen, prosperous and so on. So, if this is the bio mass. So, it reactions the oxygen in the moisturized, to give you carbon dioxide, water, minerals in an achieve. So, this is what happens in soil respiration, where organics in soil react with the oxygen to give you carbon dioxide in water. And in their process generate minerals for plans uptake, generate energy for the biological process of soil.

So, waste organics that you all throughout and from or homes in all that, that is oxides to release energy for soil process, release minerals for plants to take up and then release that carbon dioxide once again, it is important nitric from plants. In other words what we are trying to say here is that, waste organics actually serve a very valuable purpose. They give carbon dioxide for plants, they give minerals for plants, at the same time provide energy for biological process of soil. But, this waste organics that is around, if it is does not go to soil for whatever reasons, then it accumulates in the urban environment, to create various types of problems. And this is what we face around the world, of course, the problem very serious in a cities like Bombay or if you go to city like sample in Brazil there are very serious problems, urban areas are in very bad shape.

Now let us look at the opposite. That means; carbon dioxide plus plotter plus mineral plus energy is photosynthesis, that we know. On other words, respiration and photosynthesis are complimentary chemical reactions of our environment. And if we can engineer, our processes so that, this complimentarily is there in our desire, even for urban systems, then clearly we would not face problems of waste management. The problem is that, this energy between photosynthesis and the respiration does not seems to happen in the urban areas of the world. This is the fundamental problem for which we do not seem to have good solutions. But, the fact the contact towards this is; this is the gas solid reaction. And whatever learnt we have learnt so far is that, this gas solid reactions we understand therefore, we understand how to design such systems if they are required. Let us take one more example of greater importance.

(Refer Slide Time: 32:44)



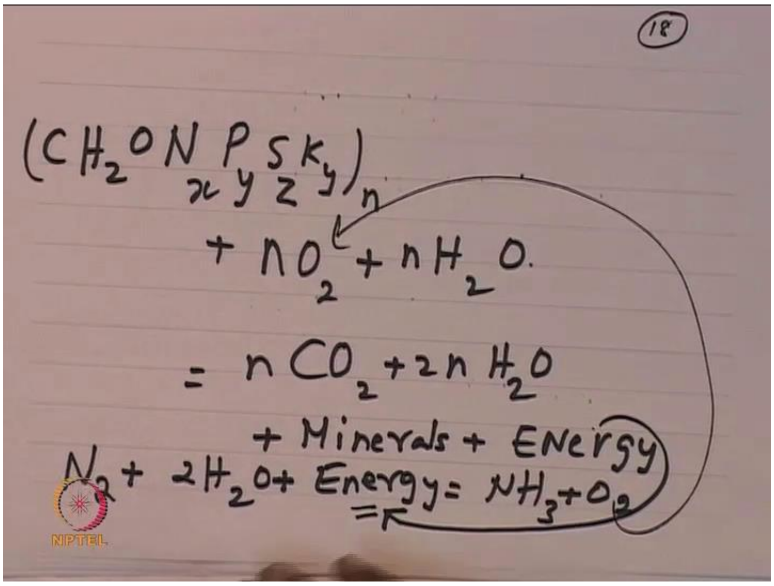
Now, what is this reaction, you already in your school I suppose? Primary mineral reacts with carbon dioxide in the presence of moisture water, to give you this mineral which goes into solution and this bi carbonate which goes into solution. In that process, generate soil or clay or sand. Now let us put it in the context. The context is; this is what is called the mineral weathering, this is also a gas solid reaction.

Now this reaction, gives number of things; in fact production of soil, production of clay, production of sand. For example, we mine lot of sand around the world, including in Bombay city and how does it get produced anyway? This production is takes out because of this reaction. This reaction goes on the environment, then primary mineral reacts with carbon dioxide of the environment to give you sand. In some places, it is formed over millions of year therefore, we can mine forever. There is clay, if you go for bacteria for example; huge amount of clay is mined for various purposes you know, for industrial purposes. And this clay was formed because of this reaction.

So, mineral weathering is a source of several products for human activities that power the industries of the world; clay for example, or sand for example. We make lot of glass around the world using sand for example, because we are able to mine and this is come from this reaction. What is soil? Soil is reaction between primary mineral and carbon dioxide in the presence of water. So, or in other words if you ask a reverse question, can we makes soil in a factory, is it possible, can we make clay in our factory, can we makes sand in our factory? Because you run out of factory, Bombay city has no sand for construction is well known. The part of the reason why the or construction in Bombay city for example, lots of cracks because, we do not get good sand in the city. If you go to Jaipur for example, constructions are excellent, very good sand is available.

Now, if we have to overcome this problem, then we have to make this material in an industry. Can we do this, can we engineer this reaction. So, we do not have to worry about mining our raw materials for industry from the environment, make it ourselves. What this reactions says, it is possible, you see. If you can spend our time to study this reaction, we can make soil is you make clay, we can make sand. So, it is a solid reaction. Are we short of carbon dioxide? No. Are you short of primary mineral? The largest resource this country are throughout this country. Billions of rock is around. We have not even looking at its kind of possibility to solve a problem, you see. We much bring carbon dioxide of industry with the primary rock, then these kind of things become possible.

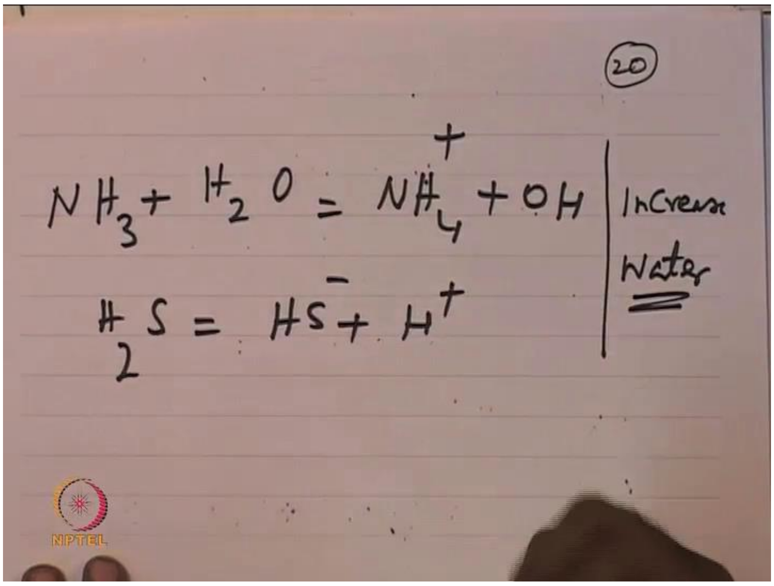
(Refer Slide Time: 36:37)



Let me give you 1 more example. The reaction is not balance, but, what is this reaction? Nitrogen plus water plus energy gives ammonia plus oxygen. Where this energy come from? This energy comes from this energy comes from biological respiration. So, this energy, if you put it here that, if this energy of respiration in soil, can be channeled into nitrogen fixation path way, we get ammonia which we manufacture in our factory. Not only that, we get oxygen which becomes a product of this reaction. This oxygen can go here. See this energy, how beautifully this environment has evolved, which we do not simpler appreciate. If this energy can be stables; that means, the energy our aspiration, if we can channel into path ways of soil for nitrogen fixation, then this oxygen can support respiration and look at the other alter.

Suppose we do not do this, carbon dioxide accumulates. Our waste product accumulate see. So, movement we break this energy, all tops a problem starts to amount. In other words, environment if you bound energy in chemical reactions. That is the most important message that comes from the environment. This it is all energy. You break the change, problems after problem will arrive. So, by in large our design in the future, off course our time is up, but, you time is test starting, your design must looks at energy is within natural processes of the environment. Then by enlarge, your designs would be long living and it last very long time.

(Refer Slide Time: 38:55)

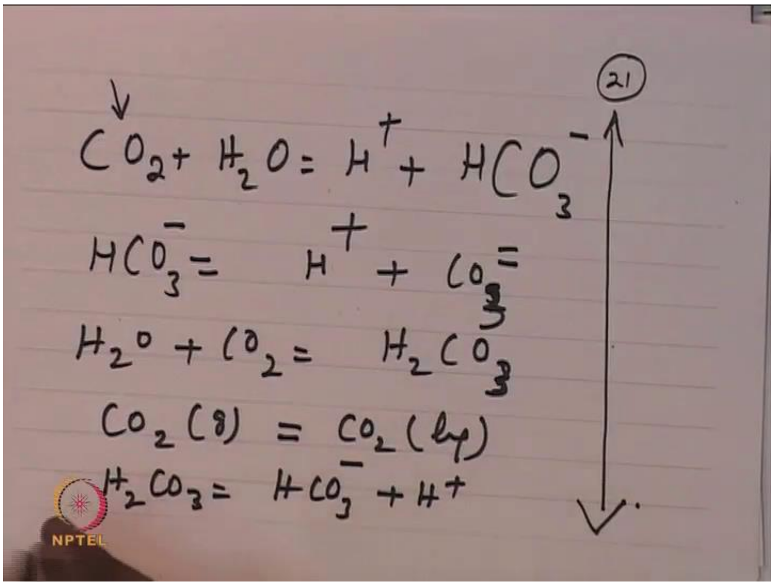


With this, let me ask if you questions. First question; where to see this reactions happening in daily life? Daily life at our homes, in our daily environment where do see this? Where to encounter? We encounter this problem in its most series form in public toilets, most serious form and why is it? The reason is that there is in enough water, because there is in enough water, I have got number here which says; in households were the water is not abundant upto about 10 grams in 50 liters of ammonia can accumulate; 10 grams of nitrogen in 50liters. And this is what you know then this it cannot hold so much, it simply creates problems, ammonia comes out, hydrogen sulphate comes out and its very obnoxious can in environment.

Now in the initially when these a flushes design, you will find that the designs flush that we do nowadays; it does not hold more than about 4 5 liters of water because, there is water around anyways, you cannot put. When it was design 100 years ago, it has something about 25 liter of water. So, 25 liter reduce into 5 liters. In that process what was happen is concentration some gone up. And because concentration gone up all this problems becomes more serious you see.

So, if you have to solve problems like this; for example, if you have to get read off of I mean obnoxious water in public environment, what you do? We have to increase availability of water so that, you can dissolve this neutrinos in large quantity of water. Then only these problems will go away. Another word, solving this problem is the you have to increase availability of water. I mean such as not available, you have to increase availability of water. In other words you must look very seriously at ways of reclining waste water. You see from in more serious of the developing, what most serious problem of dense population like; Bombay Sam polo etcetera.

(Refer Slide Time: 41:48)



What do you understand from these reactions? Carbon dioxide reacts with water give you H plus, H C O 3 reacts for the gives C O 3 minus, carbon dioxide and water form H 2 C O 3 carbon dioxide dissolves in liquid. So, what is this reaction I mean in terms what you see in our natural environment, what shall we say? These are reactions of carbon dioxide in our environment. Now if the carbon dioxide concentration in our environment goes up for whatever reasons, what happens to these? Suppose carbon dioxide concentration environment goes up, it increases. What happens to all these products? You expect it go up.

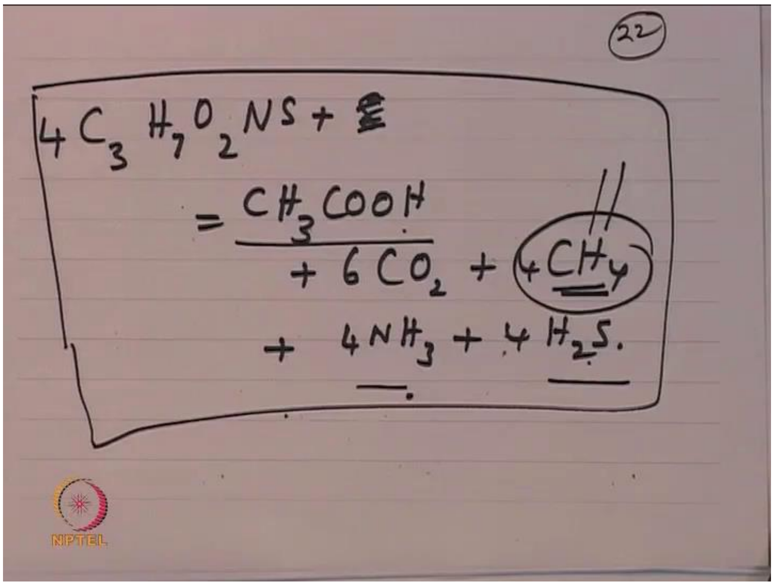
So, we should expect H plus of our environment will go up. So, you would expect that see whatever it will become acidic correct, see whatever it will become more acidic. And what will be the effect of what a becoming a acidic? In a physical sense, when carbon dioxide concentration goes up, H plus goes up, what is being said is that; as H plus increases in sea water, the sea water capability to cold carbon dioxide decreases. You will find in the natural environment, lot of the carbon dioxide in this planet is in rock it as carbon rocks.

Now lot of it lot of the carbon is present which is now becoming carbon dioxide, you do well comparison and so on. And therefore, the effect of carbon dioxide in the environment, happiest effect the holding capacity of carbon dioxide sea water, sea water holds close to 4000 billion tons of carbon dioxide. So, therefore, it has this net effect of increasing the C O 2, making sea water even more acidic, creating more and more problems for aquatic life apart from increasing a carbon dioxide.

So, what we are trying to say here is that, these reactions essentially determine how life in this planet will perform. And our designs must respect this chemistry and that chemistry is what that the carbon dioxide concentration in our environment is about 300 p p m because, it is this chemistry which has been able to evolve life and there are life that you and I see today is because of the factor thus chemistry that work for billions appears. So, that respect must come.

So, this is another feature that we must content in our design. Just look at 1 more example.

(Refer Slide Time: 45:40)



What is this reaction? What you make order this reaction? It only says; suppose you have a biomass, this can be a protein, you and like consume a lot of protein which contains sulphur. And if there is reaction takes place in limited supply of oxygen; that means, wherever there is limited supply of oxygen, which is waste dump is the good example, oxygen availability limited, when you find you produce as it there is production of acidity and then you also produce ammonia and hydrogen sulphate. So, you will find that, places of accumulation of based organics. Its acidic, environment acidic and also there is ammonia obnoxious well because a hydrogen suphate and ammonia.

In other words what we a saying is that, if we prevent the aerobic respiration from working, if this does not work; that means, availability of oxygen is limited, then this will happen and we see this in whatever we have done. So, what the, what is called as the United Nations panel for climate change and all there, what they are saying now is that, this particular material is what is creating a huge amount of problems in terms of global warming. While we cannot prevent these reactions, what they are saying now; let us capture this. If we capture this burn it, then the effect of this see the global warming potential of the methane compared to the global warming potential of carbon dioxide; methane is much worse may be 6 7 times worse than carbon dioxide.

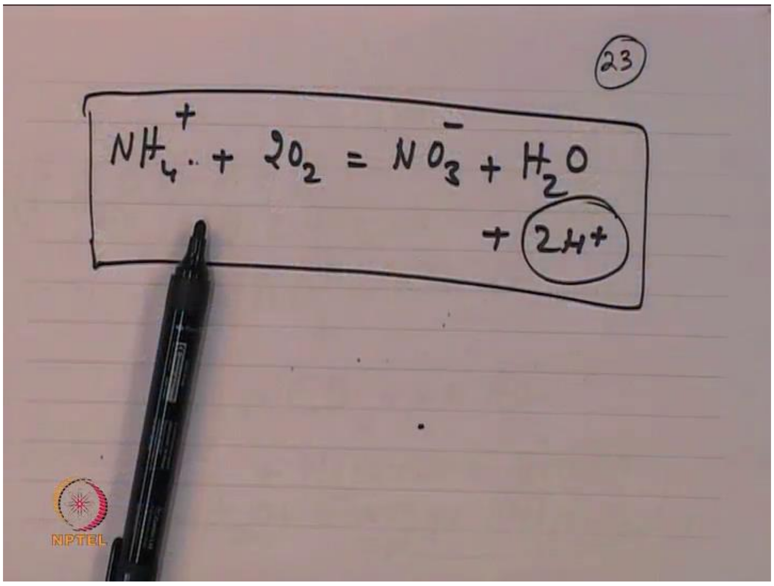
So, they are looking at the way by which we can capture this methane so that, you know we can capture it, burn it, perhaps in a boiler, perhaps at home whatever, then what is inward in this reaction? You have to biologically convert this to methane in enclosures while you can capture the methane. So, in what we want to do in biological reaction engineering, concerned with environments, you would prevent global warming by capturing methane. Alternatively we will ensure that, the availability of the oxygen is such that the anaerobic respiration takes place. Supplying oxygen cause many, anaerobic reactions do not put so much demand on oxygen.

So, there are certain advantages, there are certain disadvantages, we will come to that shortly. If we can do it, nothing like it, for example, if you can maintain an aerobic environment in the waste dums of the world for example, in Bombay or may be similar dums in other parts of the world, then these problems will not come. But, what seems to be happening is that, the urban areas of the world there is no space, there no space in the city of Bombay. So, what do you do you? Keep on piling up wastes and therefore, these reactions will occur, there is no space correct.

So, what is been thought of now is that, alright since there is no space, let us keep on putting it in the same area, but, capture this methane and we will use it appropriately. This is the present thinking. Yes, yes, it is methane when the methane and carbon dioxide together, people call it as biogas, people call it as gobar gas, may this thing depending upon the type of raw materials. Whether this would solve a problem with something people are battling with, present situation appear to be that, the cost at which we are able to capture this methane, seems to be not very satisfactory. We are not able to afford cost of collection of this methane from this waste dums of the world because, that collections cost lot of money. But, if you have an enclosure in which you have react a design capture that methane, the cost become even higher. So, unless the economy satisfy, it is not worth we are looking at.

So, that these are issues that we are facing, but, the fact is; in the absence of oxygen this reaction will occur, in the presence of oxygen these things will not happen. All these productions will not happen, hydrogen sulphide will become sulphate, it will get oxides to sulphate, nitrogen get oxidants to nitrate and methane will get oxides to carbon dioxide where in oxygen rich environment, we are looking at all of them in it is highest oxidation states and therefore, we left the oxidized products and so on.

(Refer Slide Time: 50:50)



What is this reaction? It is not clear please what is what is your question? What I said was; if there is inadequate supply of oxygen, what happens in waves dums of the world, aerobic reaction sets in and methane is produced. Now since these dums are not designed for capture of methane, this methane goes into the atmosphere. Since the global warming potential is several times that of carbon dioxide, this is very deleterious effect on the environment. What is your alternative? The alternative is that we have designed dums, dums are designed so that you can be capture the methane. There are many places in the world where they do this, it cause money. Alternatively you this waste material is taken to a biological, where you capture the methane and then you take it for whatever purposes.

So, waste dums; you have to design it to capture the methane or you take the waste directly to the bio mathematician so that, you can capture the methane. Both are been practiced, but, there are problems of economics, as a result we are not able to implement. What is this reaction and what does it have to tell us? Where we see this reaction ammonia oxidation? Nitric acid factory correct, nitric acid factory is where this happens alright. Now we are not talking about factory now, we are talking about soil. In soil this reaction takes place when you put proteins into soil or you put urea into soil. Or in other words, nitrogen to soil this reaction could takes place.

Now what happens to this H plus in soil? It increases the acidity of the soil. Now what is it we have observed around the world, India in particular; if you go to for example, a good example would be Gujarat. See Gujarat is 1 state where, because of these 2 rivers Tapi and Narmada, there are lot of ground water, 1940s there are lot of data1940s ground water in Gujarat with the t d s or the deserved solids over 250 to 500; in the range of 250 to 500, excellent quality water. 50years later it is 10000 why is it? It is because, this H plus reacts with minerals of soil and dissolves those minerals, are you know accumulating in mineral water.

The water which was in an excellent shape 50years ago has become unsuitable for drinking, unsuitable for agriculture. It is something that we have done partly due to agriculture, partly due to human interferences with the natural processes, partly due to huge amount of carbon dioxide we generate in our industry and so on. So, what is required see all these are reactions, biologically mediated reactions. All these have a technological solution; we have to understand this technological solution. This is what we want to do in the next few classes. Try to see what is that, you and I can do towards understanding the foundation for these 2 problems and to put in measures. That will at least you know partly reduce these problems of the environment. I will stop with that.