**Back in the mid-nineteenth century, when the first oil prospectors started distilling the black stuff into kerosene to replace the prodigious quantities of whale oil that they’d previously been using to light the world’s lamps, their newly discovered process also created a bunch of byproducts. Some of them were heavy and gloopy, and they became quite useful as things like waxes and lubricants. But the process also produced vast quantities of a very light and extremely combustible liquid, which wasn’t useful for anything at the time, and which was really nothing more than a dangerous fire hazard. The solution those early pioneers found to that conundrum was simply to dump this hazardous substance, in enormous volume, into local creeks and rivers. Back then, of course, people had no concern for the environment at all, did they? I mean they were just completely ignorant!**

**Nowadays, we’re…erm…we’re… anyway, the point is, times have changed. The advent of the motor car meant that this previously annoying waste stream which, in case you hadn’t clicked, was gasoline, came to be one of the most indispensable liquids known to human civilisation.**

**Modern petroleum refinery processes are now so efficient and effective that around eighty percent of oil that gets extracted from the ground is transformed into a commercially viable product of one description or another, and even the remaining twenty percent is used within the refinery itself to provide heat for the various processes. So pretty much nothing is wasted in a modern processing plant. The slight wrinkle is that, depending on the refinery and type of crude oil used, between seventy-five and eighty-five percent of each barrel ends up as a combustible product. And I’m sure you don’t need me to point out the consequences of that.**

**According to the oil industry PR machine, it is simply not technically possible to make all the durable, non-combustible products that our modern world is based on without first producing hundreds of millions of tonnes of gasoline, jet fuel and diesel. If the world wants to stop burning hydrocarbons, say the fossil fuel oligarchs, it will need to find some pretty big creeks and rivers into which the oil refineries can empty out what would once again become a redundant waste stream.**

**And, it turns out, that is completely untrue.**

**Hello and welcome to Just Have a Think.**

**Now, not for the first time, I find myself having to hold my hands up and admit that I am not an expert in the subject on which I am about to pontificate. I certainly have absolutely zero experience of working in the petroleum industry.**

**But I know some people who do. And I had a little Zoom chat with one of them recently so that he could educate me a little.**

**His name is Paul Martin and he’s a Canadian chemical process development expert with decades of experience in the design and construction of modular pilot and demonstration-scale plants for the petrochemical industry. Paul now runs his own independent consultancy called Spitfire Research Inc. based in Toronto, Ontario.**

**Before I get to some of Paul’s pearls of wisdom about how the inner workings of a modern petroleum refinery could change in the future, it’s worth having a quick look at the basic principle of how these contraptions work.**

**A barrel of crude oil contains thousands of different hydrocarbon molecules, plus usually a bunch of sea salt and other detritus that gets scooped up in the extraction process. Once the salt and other impurities have been removed, the oil is heated in a furnace and fed into a distillation column where it separates out into different hydrocarbon components or ‘fractions’ based on their boiling points – hence the name ‘fractional distillation’. The very lightest fractions, like propane and butane, boil off first and come out of the top of the column. Then you get gasoline, and then kerosene, perhaps better known these days as jet fuel, and diesel…followed by increasingly heavier substances that have higher and higher boiling points, until you’re eventually left with a nasty gunk down here at the bottom which simply refuses to evaporate at normal atmospheric pressure. That ‘gunk’ gets sent into a second chamber called a vacuum distillation column, where pressure is reduced down to somewhere close to one thousandth of an atmosphere, and the distillation process starts again, producing a light top product called vacuum gas oil or VGO, some heavier fractions in the middle that can be used as lubricants, heavy fuels and chemical feedstocks, and finally some seriously nasty stuff at the bottom called vacuum residuum, or pitch, or more usually referred to in the industry as ‘Resid’. You can think of that as being a bit like liquid coal – basically the stuff that won’t boil off even at three hundred degrees Celsius in a near vacuum.**

**Although it’s a very clever process, distillation alone is a fairly limited tool. You kind of get what you’re given by nature as a result of adjusting heat and pressure and collecting whatever boils off at the various different levels in the columns. But as any economist will tell you, supply and demand are rarely balanced out simply by hoping for the best. So, as the refining industry matured, additional technologies were developed that could tweak the distillation outputs with ever increasing accuracy so the petroleum industry could provide its customers with precisely the products they required, in the quantities they were asking for and at exactly the time that they needed them.**

**New machines were developed, like Fluid Catalytic Crackers, or FCCs for example…**

 **“So, the refiners had to invent new process technology in order to make use of the fractions of petroleum that didn’t have an obvious initial use and one of the…probably the most magical of all is the fluid catalytic cracker. I happen to have some FCC cracker here in my hand and you can see how it behaves almost like a liquid, it’s so flowable. And that machine basically turns garbage in a refinery into gold, it takes big molecules and breaks them into smaller ones that you would use in gasoline and the like, where the real value is.“**

**Then there’s catalytic reformers that ‘dehydrogenate’ hydrocarbon chains to produce ‘aromatic hydrocarbons’ like benzene, toluene, and xylene, and high-octane alkenes that prevent knocking in internal combustion engines.**

**There are also ‘alkylation’ units that react low-value outputs like isobutane with propylene and butylene to produce high-octane products that can also be blended into gasoline.**

**Then in the early to mid-twentieth century, polymerization came along, enabling refineries to combine small, simple hydrocarbon molecules, known as alkenes or olefins, into polymers that could make stuff like polyethylene and polypropylene, as well as resins and synthetic rubber. And the plastics boom was well and truly born.**

**The intricate technicalities and chemical reactions involved in all these processes are outside the scope of this video, but the result is an incredibly intricate ‘spiders web’ of modern-day commodities.**

**This bewildering mass of technical terms and spaghetti lines is based on a flow chart published by an organisation called the Independent Commodity Intelligence Services, the original version of which you can go and view for yourself via a clickable link below this video.**

**The bottom line, entitled ‘applications’, reveals rather starkly the myriad products derived today from oil and gas, without which our way of life, at least here in the West anyway, would simply disintegrate, leaving most of us struggling to survive for longer than a few weeks or so. Which brings us back to the original question in the title of this video.**

**Here's Paul Martin again…**

 **“What I see a lot of these days is er, generally fossil fuel advocates saying there are so many valued products coming out of petroleum, and we would lose all of those products and we wouldn’t be able to make them anymore if we didn’t make diesel, gasoline and jet fuel and so on. And that’s just not true. It’s technically possible, and in fact technically possible without a single new invention required to refine petroleum without making any gasoline, diesel or jet fuel or the like, er but it would be costly, and it would require significant changes to the refinery.”**

**One of the most significant byproducts that would need to be dealt with is something called ‘Fuel Gas’, which is derived from the fractions coming out of the top of the distillation columns and some other process units and gas mixtures, whose molecular structures are so hopelessly intertwined that it would be too expensive to attempt to separate them out.**

**The simplest and most economic thing to do with them today is to burn them, and use them as a source of heat to drive the various endothermic processes within the refinery itself. Right now, there’s no incentive for the refineries to treat that gas in any other way, because they have this enormous, completely free, open sewer known as ‘the earth’s atmosphere’ that they can dump all their exhaust waste into with complete impunity.**

 **“and er we would need to figure our what to do with that CO2, whether it’s to reduce it chemically by reacting it with hydrogen to make carbon monoxide which we can use in other processes to make chemicals again, or capturing it as CO2 and burying it. “**

**And the refineries of the future would have to be set up differently, with robust procedures for capturing the very lightest products coming off the top of the distillation column and converting them into non-combustible products.**

 **“In some of the processes you get things as light as methane, which is about as light as hydrocarbon gases get, er and you also get ethane and propane and butane and so on, er off of those processes and a lot of those things are used as fuels both in the refinery and out in the rest of the world. Fortunately, we already know what we can do with those things and that’s to put them through a reformer. And then once you’ve got syngas you can make a variety of different things, you can make methanol and chemicals derived from methanol like acetic acid, but you can also feed it to a process called Fischer Tropsch, and Fischer Tropsch will allow you to make straight chain hydrocarbons as big as you like , up to C40 – all the way up to heavy waxes if that’s what you want to make. The question is what are we willing to pay per tonne of CO2 emissions avoided and what’s the best way to achieve that result? Technically, there’s no problem. We definitely can do this. “**

**It's probably also worth pointing out that even if we did manage to eradicate combustible fuels from refineries, there is still a long list of pitfalls that would need to be faced including the very common practice of so-called ‘flaring’ at production platforms.**

 **“Flaring is sometimes cast as an unavoidable thing by the petroleum industry but in reality, it’s a regulatory thing. There are certain regulatory regimes in the world that have just basically banned flaring except for emergencies, but there are other jurisdictions where gas that comes up with petroleum when it’s produced, so-called ‘co-produced gas’, is you know a few hundred kilometres away from anyone that wants gas, so building a pipeline would be expense. So, a burner is cheaper, and they’re allowed to just do that. And those sorts of, you know, sins against the environment, if you will, that arise from regulatory inaction – those need to go away. And of course there’s the large issue of, right now, with these giant gas networks that distribute gas over hundreds or even thousands of kilometres, and every pipe leaks a little bit, every joint, every flange leaks a little bit and that’ll have to be taken care of, but again, mostly the gas industry is a self-fixing problem because the way we’ll fix those problems is by not using natural gas anymore, period.**

**On Thursday the 30th of November the COP28 climate conference kicks off in the United Arab Emirates which, as I’m sure you’ve already noticed, is being chaired by the CEO of Adnoc, one of the largest oil companies in the world. The conference will have an entire dedicated pavilion given over to OPEC for the first time in COP history, and there will be more than a thousand fossil fuel industry lobbyists in attendance, larger than any delegation from any of the world’s nation states. Many see this is a rather obvious and desperate attempt to slow progress on global decarbonisation, but despite their best efforts, the oil and gas behemoths know what’s coming…**

 **“The fossil fuel industry is staring into the abyss. You know, if we actually get the seriously interested in decarbonisation and put in place the policy measures to make that happen, then we’re going to see the natural gas business almost completely evaporate…and the petroleum industry is going to shrink to at most a quarter of what it is today, making chemicals and plastics and the like, erm, you can distribute that around the world and have one big plant on each continent to do that. You don’t need one next to each major city, which is kind of the way that we’ve been dealing with petroleum.”**

**One of the biggest challenges, or perhaps one of the greatest global opportunities since the last industrial revolution, depending on how you look at it, is for governments and commercial operators around the world to work hand in glove to re-deploy hundreds of thousands of skilled trades and professions out of a dying industry and into very well-paid skilled jobs in the renewable energy sector of the future.**

**And of course, none of this takes away from the fundamental need to address the root cause of the climate and ecological crisis, which is rampant over consumption, profligate waste, and the abuse of our precious atmosphere, ecosystems and oceans as open sewers into which we currently dump all our pollution. Recent history shows us that changing that paradigm will NOT happen voluntarily. Like it or not, this is where governments will play a vital role, by enforcing strict regulations to ban emissions and by imposing high carbon taxes to penalise persistent offenders.**

**So, make no mistake, this video is no way attempting to suggest that there’s a nice-neat solution at our fingertips simply by having a little chat with the folks over at ‘fossil fuel HQ‘ and asking if they would be kind enough to upend their entire reason for existence!**

**If the market for combustible products does start to vanish before their very eyes though, then oil and gas producers will either have to adapt or die. And the market IS changing, despite the relentlessly disparaging misinformation that floods mainstream and social media on an almost daily basis. Nations that truly understand what’s coming and robustly seize the opportunity will lead the way on the world stage. Those that fail to see the writing on the wall will most likely fall by the wayside.**

**Now I reckon there’s a reasonable chance that one or two of you good folks out there might just have your own strong views on this particular topic, so I will go and make a pot of strong coffee, put on my metaphorical hardhat, and I’ll see you down in the comments section shortly!**

**That’s it for this week though. Thanks, as always, to our Patreon supporters, who keep ads and sponsorship messages out of all of these programs. If you haven’t been mortally offended by the contents of this presentation, and you feel like you could support the work I do here at the channel each week, then why not pop over to patreon.dot.com forward slash just have a think to find out how you can get involved.**

**And you can hugely support the channel right here on YouTube absolutely for free by subscribing and hitting the like button. It won’t cost you a penny to do that, and it’s just a simple mouse click away, either down there somewhere, or on that icon there.**

**As always, thanks very much for watching! Have a great week, and remember to just have a think.**

**See you next week.**