

Play intro jingle.

NICHOLAS MCCAY 00:04

Hi. I'm Nicholas McCay, and this podcast is brought to you by my colleagues, Salma Atallah, Karl Dagher and myself, students at the Technical University of Munich, Department of Science, Technology, and Society.

Play small jingle.

JOHNATHAN DAGHER 00:18

We're talking about mismanagement and mishandlement at every step of the way from the highest level of the hierarchy to the smallest employee at the port.

DR. VYTO BABRAUSKAS 00:26

They are 100% avoidable.

FRANCESCO AMODIO 00:30

In the end it's politics.

NICHOLAS MCCAY 00:39

There is perhaps no greater story to illustrate the benefits and risks of science and technology than that of German chemist Fritz Haber. He was awarded the Nobel prize for chemistry in 1918 for his invention of the Haber-Bosch process which enabled scientists to transform the nitrogen present in our atmosphere into ammonia, allowing crops to absorb the compound's nitrogen molecules much needed for their growth. Effectively, Haber was able to create quote: bread from the air, unquote, as the press described the achievement at the time. The Haber-Bosch process is essentially what allowed the world population to grow to today's figure of 7.7 billion. But Haber's peers were not too happy that he won the Nobel Prize, for he was also involved in some nasty business. He had invented chlorine gas which was used in

the trenches of World War I by the German army and was responsible for the gruesome deaths of thousands of Allied soldiers. He also invented the deadly pesticide Zyklon, which was later used by the Nazis in their gas chambers during the Holocaust, and in a cruel twist of fate, Haber's invention claimed the lives of some of his own relatives.

Haber's story illustrates the duality of a scientist's work, or how science can be used for good and bad. Through that lens, this podcast episode looks at how society manages life in the face of this duality. Specifically, we look at an item classified as dual use:

Ammonium Nitrate. Born out of the Haber-Bosch process, Ammonium Nitrate is a popular fertilizer used all around the world, but also a dangerous explosive that has claimed many lives.

But before we zoom in on ammonium nitrate, let's start with a general question: items are classified as dual use to manage their benefits and risks, so how does that classification happen?

FRANCESCO AMODIO 02:26

In the case of what typically would happen is that government that is interested in these things, would consult with experts, scientists, and so on, and would come up with what they would consider a dual use item, and the militaries can be involved in the process as well. Because there is expertise in this respect.

NICHOLAS MCCAY 02:43

This is Dr. Francesco Amodio, associate professor of economics at McGill University in Montreal. His research focuses on constraints for economic growth and entrepreneurship in low-income countries. He has looked into the effects of security-motivated

trade restrictions on economic activity
in the West Bank, so he knows a few
things about dual use material.

FRANCESCO AMODIO 03:04

It's very difficult to say where you
draw the line and consider something
dual use versus not. And, you know, in
the case of chemicals, a lot of it has
to do with the concentration of things.
So, you may not want to ban a chemical
overall, but you may want to ban it if
the concentration is higher than this
much per milliliter. What I'm saying is
that there is several ways of drawing
that line. In the end, its politics,
but these decisions, are informed by
experts in various domains.

NICHOLAS MCCAY 03:29

Let's hear what these experts have to
say about ammonium nitrate. We'll start
with Dr. Hans Pasman, emeritus
professor in Chemical Risk Management
at the Technical University of Delft in
the Netherlands.

DR. HANS PASMAN 03:40

Ammonium nitrate is a very good
fertilizer because it contains so much
nitrogen and the plants need
nitrogen. There are other alternatives,
but, well, costs come in,
transportation comes in and it's
easier, but still the best and most
convenient thing to have...prilled
ammonium nitrate.

NICHOLAS MCCAY 04:01

And prilled ammonium nitrate is what
we'll find most commonly in the
agriculture industry. And those prills
look like...

DR. HANS PASMAN 04:08

White droplets, kind of. Diameter of
each droplet is something like 2, 3, 4

or 5 millimeters. Usually, it is all loose. So, you can kind of pour it from a bag or from even from larger load to a heap and that's it. So, for the farmer he can fill a thing that swings around and put it on the land.

NICHOLAS MCCAY 04:30

The size of the prills and the convenience with which they can be used are a major factor in the popularity of ammonium nitrate in the agriculture industry. It can be used for increasing crop yield, improving fertility of soil types, controlling growth of vegetation mass, increasing gluten & protein content in grains, and many, many more purposes. But then, how does it explode?

DR. HANS PASMAN 04:52

The prills are rather kind of small droplets you could say so, that is rounded etc. Now, this is the most popular mode in which ammonium nitrate nowadays is manufactured, shipped etc., and used. And there are two kinds roughly: one is for fertilizer, and one is for explosives manufacturer and that is low density. There are lots of complications because the high density can turn into low density just by thermal fluctuations.

NICHOLAS MCCAY 05:23

So, ammonium nitrate can actually be *manufactured* to be used as an explosive. When did this realization happen?

DR. VYTO BABRAUSKAS 05:30

I think basically the late 1950s, to early 1960s. In America, there's a lot of explosives used in civilian non-military applications, and they have to do with road construction, with mining, with major earthmoving projects

with things like that. And they used to be using things like dynamite and TNT, nitroglycerin, and things like that. And then they discovered in the late 1950s to early 1960s, that if you mix ammonium nitrate with fuel oil, and you make what's called ANFO, that it is very easy to transport. It's easy to manufacture. And first and foremost, it's cheap compared to other alternative, explosive substances. So that was the basic reason why that became so popular for those industry sectors.

NICHOLAS MCCAY 06:25

That was Dr. Vyto Babrauskas. He operates his own consulting and research firm called Fire Science and Technology, Inc. He also does a lot of work in forensic science, and his research delved into ammonium nitrate explosions. It comes as no surprise then, that he has strong opinions about it.

DR. VYTO BABRAUSKAS 06:42

These accidents, in my view in my analysis, and I did a lot of investigation. They are 100% avoidable. As the manufacturers, you cannot make useful ammonium nitrate safer, but what you can do is make a very modest substitution, namely, substitute Calcium Ammonium Nitrate, for ammonium nitrate, even though that is largely an ammonium nitrate based product, there has never been an incident where a disaster occurred, and somebody got blown up with the product and there are tests, there are laboratory tests that suggests that, that would be maybe not impossible, but certainly extraordinarily difficult to arrange.

NICHOLAS MCCAY 07:27

Calcium Ammonium Nitrate is commonly referred to as CAN. C-A-N.

DR. VYTO BABRAUSKAS 07:34

CAN is a substance that's possible to substitute directly for ammonium nitrate with a very slight loss of efficiency. There's a slight penalty of agricultural value, but you can then have to make a balance between agricultural value and especially, you know, I'm sensitive because of the profession I'm in to first responders, that first responders innately have a dangerous and difficult job. And I personally think it's wrong to expose them to a gross possibility of being blown up when we don't have to do that.

NICHOLAS MCCAY 08:12

Vyto touches on an important point: the safety of first responders. We usually take it for granted that if we're ever caught in a disaster, natural or man-made, we can count on them to save us without giving too much thought about their lives. But one particular story paints a darker image.

Play ominous jingle.

NICHOLAS MCCAY 08:30

In August 2020, the government in Lebanon went beyond neglecting the lives of first responders. It knowingly sent them to their deaths. When a fire broke out at Beirut port that afternoon, the city's fire brigade was called to the scene. The crew of nine firefighters and one paramedic arrived to find the fire raging inside Warehouse number twelve, but its door was locked. As they tried to break the lock, 2700 tons of ammonium nitrate were sizzling inside the warehouse, closer to the point of exploding. Although officials knew the dangerous

cargo was stored in the warehouse, and although only two high-ranking port officials held the keys to that lock, this information was never shared with the fire brigade. The ten-person crew met their fate at 6:07 pm, when the chemicals exploded.

JOHNATHAN DAGHER 09:26

It was apocalyptic.

NICHOLAS MCCAY 09:27

This is Jonathan Dagher. He's a journalist investigating the Beirut port explosion. He was also 700 meters away from Warehouse number 12 at the moment of the blast. In this section of the podcast, he tells us his story. Its violent details might be triggering and cause distress to some listeners. Discretion is therefore advised.

JOHNATHAN DAGHER 09:47

It happened at 6:07pm, I think, and for a while, like there were like, because I was there. I was very close. So, for the next three hours, I had no clue what was happening. People were saying it was a ship that blew up at the port.

Some people were saying no, it was like, a bombing, or a terrorist attack.

And then, I think the story was that there was there was a fireworks storage, there was a cargo of fireworks that blew up. And then that night, I went home at like 9pm. And someone was saying, oh, there's something called ammonium nitrate that was in this hangar that blew up. And I remember there was a panic because they were like, like, most people, I didn't know if it's toxic, like there are fumes in the sky. So, there was really this rush of like, close the windows, don't stay near the windows leave the city right now. This is gonna like really harm you. So that's when, that's the big

dramatic entrance of ammonium nitrate
as a concept into my life.

NICHOLAS MCCAY 10:32

What about right before the explosion?
What were you doing?

JOHNATHAN DAGHER 10:36

I was in a cab going from like point A
to point B in a street that's parallel
to the highway that's next to the port.

You need to imagine like there's the
port, there's the highway, and there's
a street and I was on that street
700-800 meters away. And I was in a cab
I was in an Uber in the backseat. And
then I remember the cab just stopping
because we heard this sound in the sky.

And it was actually, some people
thought it was airplanes. I thought it
was airplanes, but I was like, no, it
doesn't really sound like airplanes.
And then later, we understood that this
might be the sound of the air being
sucked in at high pressure into the
hangar before the big explosion. But I
remember it was, it lasted for like a
good 30 seconds. So, we just all
paused. And I remember the city was so
quiet for 30 seconds. No one was saying
a word. Everyone was really worried.

And you could just tell something
really bad was going to happen. And
then it did. Then basically we heard
this big like earth shattering, boom.

There were actually several booms
because there was the echo too. But I
remember like the cab started shaking.

And there was like, four or five
seconds before between hearing the
sound and before the shockwave hit. And
in those four seconds, I just had the
instinct to duck. A lot of people had
weird instincts. I never knew I would
do that. But I did. So, I just threw
myself under the seat in the cab. And
next thing I know, like all hell broke

loose, you know, the cab just was like it was shoved to the side. I remember it was shaking, I remember insane power, like shaking the cab for like a good 10 seconds, but it felt like way longer. And then afterwards, there was just like, dust everywhere and quiet. My immediate feeling was fear. I did not know what had just happened. And I was worried that it would happen again. I thought someone had bombed the car. So, I was like, oh my God, they're gonna do it again. And then the dust kind of settled. You could hear the screams you could see people like, you know, there were people bleeding, there were people who were dead on the floor. And just like buildings had collapsed, so it was purely chaos. Pure panic, people were crying. I remember thinking like, this sounds a bit dramatic two years later, but I remember in the moment thinking, oh my God, the world has just ended, like the scale of the explosion. And being in the middle of it, you really think this is, you know, this is horrible.

Play sad music.

NICHOLAS MCCAY 12:26

It's horrible to even imagine. And to go back to what caused this level of destruction: it's ammonium nitrate! It's a product used for agriculture. It's supposed to give life! It is unfathomable that such a catastrophe happened, so do we know how it happened?

JOHNATHAN DAGHER 12:44

It's a conspiracy of silence, you know, everyone, everyone knew that there was ammonium nitrate in Hangar 12. Everyone at the port, all the officials, almost everyone in power knew. And this is what the documents reveal. So, when we

talk about responsibility, we're really talking about an entire political regime that is more or less responsible in different ways. And this is just purely like, I'm not speaking politically, I'm speaking legally. You know, the president found out a few weeks before and his answer was "C'etait trop tard," it was too late for me to do anything about it, knowing full well that it was not too late, the least he could have done is evacuated the surroundings of the port, you know. We're talking about army command that found out in 2015, because they were asked if they would be interested in buying ammonium nitrate, you know. These are things I brushed over, but there was a letter sent to Army Command in 2015, saying, "Hey, we have 2750 tons of explosives sitting in the port, would you like to buy them?" And the army commander, Jean Kahwagi at the time, all he says is "no, we're not interested." And that is insane. You know, like you are commanding the Lebanese army, you're supposed to like, evacuate a neighborhood, if you find out there's a tiny like, explosive bomb, in one of the bins, you know, and you find out that in the only biggest port in the capital, there is 2750 tons of explosives sitting around big enough to blow up the city. And your answer is "No thanks. I don't want them." There is clear evidence of criminal negligence, of negligence that killed 230 people and injured 7000 people and destroyed 300,000 homes and left a trauma so big, like we really struggled to overcome it. It's been two years. And it's a city that blew up. (PAUSE) This is Beirut, it's the capital of Lebanon. So yeah (laughs)

Play some music. Not sure what fits here. Need a transition

NICHOLAS MCCAY 14:11

It's not just Beirut. This could happen anywhere else in the world. In fact, it *has* happened in other places. As far back as 1916 in the US and the UK, there have been dozens of accidents involving ammonium nitrate. The deadliest was in Texas City, 1947, with 581 deaths. Beirut is third with at least 218 deaths, behind Germany's Oppau with 561 deaths. In the words of Dr. Babrauskas, they were all 100% avoidable.

DR. VYTO BABRAUSKAS 14:46

The ammonium nitrate explosion safety requires you to know nothing and do nothing about the safety of explosives. It only requires one thing to be done and to be done well, is fire safety. Because if the fire safety is done correctly, there is no possibility of an explosion, and if there is no possibility of explosion, measures that guard or protect against explosion are inappropriate.

NICHOLAS MCCAY 15:13

So, what is the regulation for storing ammonium nitrate?

DR. HANS PASMAN 15:17

Well, regulation for just the storage of fertilizer, ammonium nitrate, is all over the place.

NICHOLAS MCCAY 15:24

So, there's no gold standard for storing it safely?

DR. VYTO BABRAUSKAS 15:28

No, you know, that's the crazy part, that the only really good advice are those papers that I have published. And, you know, that's not appropriate.

There should have been the people who make standards and regulations and such, should be reading them and should be taking action. You know, it's nice that I can publish something in journals, accept that and put it in print, but that doesn't do much good if it isn't enforced. And, you know, like one of the articles I wrote that, you know, FDA tried to improve the standard known as SB 400. And they did not do a good enough job. So, you know, they did some halfway measures, but it's not enough. And OSHA is even worse, you know, OSHA.

NICHOLAS MCCAY 16:12

OSHA stands for Occupational Safety and Health Administration. It's a regulatory agency of the US Department of Labor whose mission is to quote "assure safe and healthy working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education, and assistance" Unquote.

DR. VYTO BABRAUSKAS 16:33

Instead of completely visiting their regulations and revising them according to the instructions that I would give them. They basically tried to put the blame back on the industry, saying that they should have been obeying OSHA regulations in certain regards, whereas in fact, they are misquoting their own regulations, but deliberately not by error, but deliberately trying to. You know, an American, there's this phrase, C.Y.A., cover your ass.

NICHOLAS MCCAY 17:01

That's why he advocates for replacing ammonium nitrate with other substances, such as the aforementioned CAN. But there are also others.

DR. VYTO BABRAUSKAS 17:10

Now, in farming operations like in Texas, the main alternative to ammonium nitrate is urea. But urea has very different issues, and agriculturally, I don't think that agronomist would tell you it's a direct replacement that, in other words, there are situations where you can change from using ammonium nitrate to using urea. But it requires very different techniques for application, there's weather issues that are very different for urea usage and application. And ammonium nitrate is only considered to be ideal fertilizer in certain agricultural zones. And like, in America, for instance, there are states which are heavy users of ammonium nitrate, and there are states where, basically, the usage is nil. And my understanding is that that's because of soil and weather conditions that make other choices, more appropriate and more desirable.

NICHOLAS MCCAY 18:16

But there seems to be an overreliance on ammonium nitrate in agriculture. A few months ago, when Russia, the largest exporter of ammonium nitrate, temporarily suspended all exports, the repercussions were felt worldwide. With crops already suffering from a harsh winter, compounding geopolitical tensions, and a military invasion in Ukraine, food prices soared, and shortages were felt everywhere. So how feasible is it to just phase out ammonium nitrate?

DR. VYTO BABRAUSKAS 18:43

Certain countries in Europe have actually, either by government regulation, or by industry sector

action in that country replaced ammonium nitrate with CAN. This is not a situation where we need to put citizens behind a buffer zone from the explosion. This is a situation where we can and should and must eliminate 100% The possibility of an explosion and we can do that.

NICHOLAS MCCAY 19:12

So, what is the best recommendation you can give to eradicate ammonium nitrate accidents?

DR. VYTO BABRAUSKAS 19:18

If you basically went to noncombustible, buildings, avoided commingling and combustible goods, and transitioned from AN to CAN, nobody would be getting killed from ammonium nitrate explosions. So, I would recommend that we should do that.

NICHOLAS MCCAY 19:34

Dr. Hans Pasman goes above and beyond that recommendation:

DR. HANS PASMAN 19:39

UNECE that is the UN E C E in Geneva had a program earlier this year or it was late last year, whatever, to spread the word to a lot of countries that have to deal with ammonium nitrate. And well Beirut was a kind of incentive to this to talk about what they should do to keep it safe. And of course, it is not that you keep it safe only for contactless combustibles and so on. But you keep it also locked. And there is, of course, ideas, can we get rid of ammonium nitrate. Again, we get something more from fertilizing point of view. Same thing but more safe. Or rather, the fertilizer industry says ammonium nitrate is safe. But can you get something inherently safe?

NICHOLAS MCCAY 20:25

So, store safely, regulate, educate,
and phase out. Dr. Francesco Amodio has
another suggestion.

DR. FRANCESCO AMODIO 20:32

I think advocating for transparency in
how decisions are made with respect to
dual use items is key. So that
independent of the actual final
decision that is reached, we can
actually get a sense of how it was
reached and who were the interested
parties involved, who were the experts
consulted, that had been consulted, and
so on, so that, you know, governments
are accountable for the kinds of
decisions they make. That's
unambiguously good, you know, have more
transparency in how these decisions are
made on this matter is unambiguously
good.

Play jingle to conclude.

NICHOLAS MCCAY 21:00

Unambiguously good. So, if we advocate
for transparency in dealing with dual
use material, we could get better
accountability. And accountability
means more incentives for
decision-makers and experts to do
better. But let's assume for a second
that all those recommendations were
followed in Beirut. Could we have had a
different outcome?

JOHNATHAN DAGHER 21:19

When we talk about the ammonium nitrate
that was stored at the port, we're
talking about mismanagement and
mishandlement at every step of the way
from the highest level of the hierarchy
to the smallest employee at the port.
And when we talk about that, we put

aside the alleged intentions of bringing in the ammonium nitrate. We put aside all the story of the smuggling and the ship and whether or not they were supposed to enter or not.

But once they were in the port of Beirut, if we just look at that, we can see how badly they were stored. I mean we had torn bags; they were spilling out on the floor; they were decaying for years and as a first that is one of the easiest things that we could have avoided. That is one of the easiest situations that could have been avoided. Regardless of the legal aspects around ammonium nitrate. what strikes me too is that in the course of seven years of the ammonium nitrate being stored in the port of Beirut, a lot of people knew, it was an open secret, and yet, no one spoke out publicly about this. Yes, some people did send letters to their superiors, some superiors sent letters to the judiciary. But at the certain moment when nothing is happening, no one had the political conscience, the ethics, the will to go out and inform the public and inform the media and say something. And to alert, basically the public that there is a ticking time-bomb in the middle of a very busy city.

NICHOLAS MCCAY 22:30

So, even when everything is done by the book, there can still be some blind spots within the bureaucratic messiness of government, regulation, and enforcement. Jonathan is saying that is where ammonium nitrate safety comes down to personal ethics and whistleblowing. But then, how can we explain the lack of whistleblowing in Beirut? Is EVERYONE at the port unethical and callous?

JOHNATHAN DAGHER 22:52

That can only be the result of another culture, a culture of fear a culture of silencing, a culture of corruption that stifles that turns a blind eye. How can anyone flag anything, when they don't even consider it to be dangerous. They don't even consider it to be wrong, don't even consider it to be corrupt.

And I think this is why ammonium nitrate was never flagged. And I think when we talk about whistleblowing, in the case of the Beirut port, we are talking about a much graver problem that has to do with deep, deep corruption that controls the way politics is handled at the point of Beirut and at the government at large and that is why we never heard of anything.

NICHOLAS MCCAY 23:25

But if we say that, aren't we resigning ourselves to fate? If the problem is so deeply rooted that even whistleblowing is not possible, what on earth can we do?

JOHNATHAN DAGHER 23:35

I think it's important that citizens that government employees that anyone working within the hierarchical system flag any issue that they consider a threat to public safety. And if they're not able to flag this within their own institutions then they should do this on a public level. They should take the risk, in my opinion. They should take the risk and alert the public about a threat as grave as 3,000 tons of ammonium nitrate sitting in a port waiting to explode at any moment because the truth is had anyone done that in the past seven years, we could have averted a major crisis, a major catastrophe.

Play final jingle.

NICHOLAS MCCAY 24:07

So, we can add
whistleblowing-at-all-costs to that
list I mentioned earlier. It is
interesting to note that even when
these materials are governed with
thorough technical recommendations,
sound regulation, and proper
enforcement, there can still be blind
spots. Without ethics, political
conscience, and a societal will to
safely manage ammonium nitrate, a
dangerous level of risk will always be
there. Rationalizing the problem as
both social and technical could help us
overcome the limitations of a purely
technocratically managed risk system,
maximizing the benefits of our dual use
materials, and minimizing their
dangers.

I'm Nicholas McCay, and this was
brought to you by my colleagues Salma
Atallah, Karl Dagher and myself. We
thank you for listening and hope you
enjoyed this podcast.