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THE SHEATHED SWORD: GAS PRODUCTION IN WORLD WAR II

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This tale of chemical achievement, if that is what it was, has been trying for years to escape from my custody, so here is a slice of life in wartime. Brought up in Lancashire and trained as a pharmacist, that being the nearest I could get to chemistry, it was my hope on qualifying to get away from retail and into industry. The romance of chemistry - there was still some of it about in those days drew me to a job with the Ministry of Supply at Runcorn, in mid -1940.

From what they said about the job, which was less than clear, I deduced that the factory was making a special varnish for aircraft. When I got to the place after some risk of arrest as a spy, I found the other chemists wearing curious buttonless clothing, rather like Japanese wrestlers. My issue already had a name on it. When I asked what had happened to this man they said: 'Ah, yes. Dear old George. He died'. Then they showed me a book about the medical effects of mustard gas. The pictures were horrible. That 'special varnish' was explained. During the next eight years I was to distil a ton of it in 100 ml batches, and sample 10 tons of it in half-litre bottles.

Now one of nature's finest inventions is skin. As a comedian once pointed out, 'If you didn't have skin the other parts would fall out - ain't you glad you got skin?' It also keeps out nearly everything, a rare exception being mustard gas. In those days, the choice of gloves was either surgeons' gloves or those dreadful green things that required the grip of a champion weightlifter to bend the fingers. Delicate work with glassware was not possible and, anyway, the stuff merely took longer to go through. Indeed, our worst burns were from the use of these monstrosities at the insistence of the safety officer.

It will come as a surprise to many in nuclear chemistry work that we never wore gloves. Here was a substance that did you grievous bodily harm within minutes, and we used bare hands - and there they are in the radiochemical labs handling materials that produce no visible harm for years and they wear gloves. They have black boxes, which find the stuff instantly - we had a far from simple chemical test that took half an hour (and the damage was inevitable in minutes) or we used our noses.

The use of bare hands meant that only objects known to be clean were touched. It meant a routine as exacting as the surgeon's at the operating table. The penalty for failure was severe. If you found and removed the stuff within a minute, all you got was a patch of red skin that itched. After five minutes contact you got erythema as well, and more itch. Half an hour was too late for washing. Next, day you had a full-blown blister, height two thirds of diameter, the skin so tight that it was smooth and semi-transparent. You could see the underlying. structure dimly and if you pricked it you got a fountain of clear yellow fluid. After a week it became covered with a thick, black scab which felt hard enough to scratch glass, and it itched night and day for five more weeks. If you gave in and cracked it or picked at the edges it went septic and lasted longer.

When you got back to work, your handling technique improved to perfection. You could list with deadly accuracy every article you had touched in the past three months. Your colleagues

could do the same. You knew they were right, they knew you were right, and trust and teamwork were perfect. Initiates who would not conform were brought to heel by having a bucketful of bleach paste tipped over their apparatus. Those who could not were sent away, mostly to explosive labs, and your best friend would shop you. This was sheer hard necessity, for though we all knew that George, above, actually died of TB, we were nevertheless dealing with death by the ton.

A fierce, deadly sort of chemistry, you might say? Not so; mustard gas was a friendly, dependable sort of stuff. If you did the right thing by it, it was always where you thought it was, and it never stepped out of its own territory. Explosives, now, were different. If you got it wrong, and even sometimes if you didn't, there was no minute of grace to recover by; you retired at best with fewer fingers than before.

The processmen called it 'Owd Bob'. The Welshmen were less familiar with chemicals, and would call hydrochloric acid 'the acid', and knew that there was little harm in it if you could wash it off in a few minutes. Sulphuric acid was: 'the strong acid', and you had to be careful. But mustard gas, now that was the 'real acid'.

There were even moments of pure comedy. The factory was known as: 'Th' ush-ush', this being local for 'hushhush'. When the road tankers, anonymously painted but with a yellow circle on the side, went up through the town, the kids would run alongside yelling: 'mustard gas'. They had not read the Official Secrets Act. We chemists had to ride on the tankers to see that no water got into the stuff when connections were made. Police car in front, decontamination wagon behind. When someone forgot to close a valve on the tank top the liquor began to slop out. The 'decontam' gang saw stains on the road, found these had the right smell, saw the convoy vanish into the far blue yonder and could not persuade any passing driver to take up the chase and louse up his car - they all knew, too.

The liquid was always transferred to or from the tankers by vacuum. You closed the tank, drew down the vacuum with the pump on the tanker using the main engine at low load, isolated the pump and stopped the engine, opened the valves on the flexible transfer line and waited until flow was complete. As the operation proceeded the vacuum gradually fell away and the flow slowed. This was not quick enough for one gang. They would keep the pump going. When we pointed out that spray from the inflow at one end of the tank would be drawn into the pump at the other end, they said: 'No, it doesn't. You see, all the time the pump is running there's a strong stream of "vac" running into the tank and it keeps the splashes away.'

It was factory policy, to engender team spirit among the transfer gangs, to choose the teams from small areas, so that they were close friends even away from work. This same gang came in one morning, on the top deck of the bus, to notice their tanker still connected to a storage tank. Indignantly they concluded that the night shift had 'left them to it'. So they hurried through the change-room, dashed out to the tanker without reading the log, disconnected it, roared up to the plant, reconnected and began to pump, using the quick method. Two minutes later there was a dull thud from the fast-running pump. The five cylinder Gardner diesel gave a convulsive shudder, faltered, coughed, threw wide its throttle, and with a mighty heave flung all its 90 horses into the struggle. Out of the vertical pump exhaust there rose higher and higher a glistening black column which broke into a spreading shower as the gang scattered in all directions. All except Curly, the driver. He threw his cape over his head, dashed through

the spray, kicked open the decompressor and ran for the showers, shedding his clothing as he went. Poor Curly, he didn't get it off quick enough, and was 'sensitive' afterwards.

There were two processes in use. The cheap one, by passing ethylene into sulphur chloride and a solvent, made a dirty product heavily loaded with hydrochloric acid, and very corrosive. It was only suitable for charging into thick-walled weapons, such as artillery shell, or weapons that had to be delivered before the stuff got out. This was inefficient, because what came out of, say, a 25-pounder gun was 22 pounds of steel and 3 pounds of active agent. If gas warfare had started, the inferior grade would have been delivered in more 'efficient' containers. Indeed, any brown, oily, smelly liquid dropped from aircraft would splash on landing and cause as much disruption of daily life as the real thing.

The high grade material was made by passing dry hydrogen chloride into thiodiglycol. The difficulty was the removal of the water produced in the reaction. This grade was clean enough to allow storage in thin-walled containers for long periods.

The odd, inexplicable thing, which came upon us long after the war, was the way our military customers stored the weapons we filled. The Army stored their artillery shell and other thick-walled weapons in good, dry conditions. They also had quite heavy containers for filling any sort of vessel they could think of on the battlefield. This included glass bottles for throwing at tanks-a pretty desperate tactic, for the inhabitants of the vehicle, their noses already anaesthetised by diesel stink, would go on fighting for some time before they cottoned on. Even the Army shrank from having charged glass bottles on hand. The Air Force, with their thin cans, left them out in the rain, so that although our care in the process and in lining the cans kept the inside in good condition, the cans rusted from the outside. Even after all these years I still shudder at the memory of one of these fellows who, delicately with fingertips, lifted the top handle of a large can, and raised the entire top, revealing an open vessel, brim full. How to deal with this would make a good story.

These charged weapons lay around for years after the war, since none was used, and six years production was still there. It fell to us to pick out those in worst state to decide which must be disposed of first. We would drill a hole in the side of a 75-pounder shell, through a gland with a pressure gauge, then withdraw a sample for some simple analysis. Pressures were often spectacular. Of course, we knew that the burster charge in the nose had been removed, at least we thought so until my adventure. As I lifted the drilled shell on the crook of my elbows there rolled out of the nose a thick, cellophane-wrapped disc, followed by two more. I knew what they were long before the first hit the floor, and had it all worked out. If it blew up I would not get clear in time even if I could get clear of the shell. If I jumped I would be sprayed through my drill-hole, with a high risk of getting the stuff inside my face-shield. And if it didn't go off I would be loused up for nothing. The one thought I didn't have, among many others, was that the burster charge required a detonator, fitted in the nose-cap, and there was no nose-cap. A tense moment, however.

Finally, a chilling example of Murphy's Law. We pumped our effluent direct to sea via a special pipeline over the hills collecting it first in a large open tank known as the 'elephant pit'. Well down in this pit was an electric pump, an identical spare, and a diesel pump. Any one pump could handle the whole flow with ease. The diesel, on routine test, seized. They took it apart. At that precise moment some half-wit at the local airfield flew through the power line. In the sudden, silent darkness of the pump room the two fitters, realising that the ventilation

was off too, prudently withdrew. The waters began to rise. As the news filtered up to the senior staff, one by one they hurried down there, each haunted by the thought that when the water, loaded with electrolytes, reached the motors, it was the end. The place stank of diesel oil; only when they began to notice each others' red eyes and hoarse voices did anyone realise the position. They chartered a bus and delivered the whole crowd to hospital. All came back, though with damaged prestige.