

Buying Batteries in China (Caveat Emptor)

Everybody seems to be sourcing their products from China these days, attracted by mainly by the country's low manufacturing costs. Ever since Communist Party Chairman Deng Xiaoping's visit to Shenzhen in 1984, when he gave the seal of approval to capitalism with his exhortation "To get rich is glorious", China's economy has been booming. Recent years have seen average annual growth rates of 10%. But this gives a misleading picture. The rural economy has hardly entered the 20th century and growth is slow. On the other hand, the industrial economy is actually growing at a rate much faster than the average of 10% and it's not just the scale that is increasing. It is also the scope, so that China is fast establishing an impressive technology base.

But beware - Like many things Chinese, they may not be as they seem.

Buying Chinese batteries from a product catalogue or specification sheet can get you into serious trouble. China has some of the best battery manufacturing plants in the world turning out excellent products but it also has some of the worst.

The best suppliers are managed by well qualified engineers with PhDs in materials science or electrochemistry many of whom have trained in Europe or the USA. They have made massive investments in fully automated production facilities equipped with Japanese automation equipment, working in conditions approaching semiconductor clean room standards.

The worst are no better than blacksmiths' shops with every operation carried out manually with few tools, no automation, no air conditioning, no process controls, no quality systems and no materials technology capabilities, managed by someone whose prime skills are organising an army of young workers living a long way from home.

The best companies have materials analysis labs with scanning electron microscopes, mass spectrometers, differential scanning calorimeters (DSC) and reliability testing equipment and qualified staff to use them. The worst have nothing.

Product design, quality, reliability and safety suffer the same variation - from high quality engineered products to the downright dangerous.

Sorting the good from the bad involves a major commitment to supplier qualification requiring local knowledge combined with plant visits to potential vendors and in depth assessment of their capabilities. The logistics alone can be quite daunting.

Even if you have identified high quality manufacturers, buying from them is not as easy as you might think.

You may be interested to read about some of our experiences in sourcing batteries from China based on dozens of plant visits around the country. The names have been omitted to protect the guilty.

The Bad (Don't give up before you get to The Good)

Sales Literature

One of the first problems to be encountered concerns sales literature, the product catalogues and the specification sheets. Chinese battery companies have wonderful web sites usually with flash graphics on the home page accompanied by pious mission statements. Photographs show factory buildings and manufacturing equipment and examples of typical products from a wide model range. An impressive product range will be listed with abbreviated specifications and an email to the company will get you more detailed specification sheets.

But can you believe them?

Neat graphs of cell performance may appear to be drawn with the aid of a flexicurve and don't show any squiggles and minor deviations which always occur with actual measurements. The claimed performance may seem beyond what the current state of the art is capable of, or what can not possibly be proved. A seven year lifetime of a product may be claimed using a technology which is less than two years old. One supplier quoted a reasonable cycle life of 500 cycles for their product. When we indicated that the application needed 1000 cycles, an email came back quoting 1000 cycles for the same product. When a justification of the change was requested, the answer was "Don't worry about it".

But the biggest problem in believing the specifications is that the product displayed and the factory may not even exist. Artist's impressions of new factory premises should be treated with suspicion. Fancy web sites are set up by traders, passing themselves off as manufacturers, taking your order and perhaps also taking your cash in advance. If you are unlucky, the trader could simply disappear with your money, but more likely traders will then purchase the goods from an anonymous supplier, sight unseen, branding the product as their own and taking no responsibility for its performance. Who knows when it will be ready or more importantly what will actually be shipped.

You can only find this out by going to China to see for yourself. When the supplier insists on meeting you at your hotel then the game is up, or it should be. The owner of one well known battery company presenting themselves as manufacturers refused to give up and reluctantly agreed to a plant visit. After a two hour journey to his facilities, he did in fact have a three storey factory but apart from his office, containing a single desk and a product display shelf, it was completely empty. Not even a secretary to answer the phone.

The dimensions of the company's products were non standard and suspiciously similar to those of another more well known manufacturer. Yet despite being confronted by the evidence, the pretence continued with the excuse that the products were designed and made in another factory. The actual manufacturer subsequently confirmed that they supplied product to the trader. At least they were good suppliers, but there was worse to come. More of this later.

Plant Visits

There are over 100 companies making Lithium batteries in China. The following observations are extracted from recent visits to companies offering high capacity Lithium cells.

There is a big demand for high capacity polymer (pouch) cells in China for use in electric bicycles and many manufacturers are entering the market with new product offerings. This particular factory was reached via a two hour internal flight followed by a two hour taxi journey. The General Manager (GM) had a PhD in polymer chemistry and materials science. Although he seemed technically competent and looked quite smart, to say he had the mannerisms of a rustic farmer would be an insult to farmers. Part way through my presentation he cleared his throat and spit on the glossy polished tiled floor of the conference room. I wondered if it was something I said.

The largest cells they made had a capacity of 50Ah. They did not have Lithium Iron Phosphate cells but used Lithium Manganese technology. The GM wasted his time trying to rubbish Phosphate and to persuade us to get our customers to change their preferences. He claimed that it was as safe as Phosphate but could not provide evidence. When pushed he admitted they had never done DSC thermal measurements on the material and had no equipment to do this, however he said he would get it done at some University. The plant was disciplined and clean. Supervisors tagged on to you when you entered their department and stayed with you till you left as we would expect in Europe but is not common in China. All the operations were manual except the jelly roll winding which had simple motorised mandrels.

As with any manual operations, tolerances could be a problem. There was evidence of contamination of, or minor damage to, the electrode coating at several work stations but this did not appear to worry anybody even when it was pointed out, however the operators removed electrodes which had major imperfections.

There were no quality golden samples.

Business discussions over a friendly lunch are usual with Chinese plant visits. At the lunch the GM dived into the food and didn't offer any to his guests as Chinese hosts normally do. Despite his slight frame he himself demolished at least 50% of the food on the table set for four, while emitting a range of loud noises and spitting out shells and bones into a great heap on the table, without stopping to talk.

After lunch our requirements for Lithium Iron Phosphate cells were discussed again. They offered to deliver 200 Ah cells with Phosphate technology in two months. Considering that their previous experience was only with low capacity Lithium Manganese cells this had to be optimistic.

We left the GM scratching his private parts as the deputy GM accompanied us to the door.

The visit to the next plant was eagerly anticipated though it was located somewhere in the sticks and hard to get to. It looked brilliant on paper.

Their specification sheet offers:

High capacity LiFePO₄ cells in plastic or metal cases manufactured in “first class facilities”.

Capacities 5Ah, 10 Ah, 40 Ah, 60 Ah and 100 Ah

Cycle life 2000 cycles.

Service life 6 to 7 years

Temperature range -45 degC to +70 degC

The reality was somewhat different:

The GM was a chemistry graduate - the only one with a business card.

The Technical Director, also a chemistry graduate, only arrived after lunch.

His previous experience was with another questionable cell maker.

The Technical Manager, an electronics graduate, didn't know what a feedback loop was.

They were accompanied by an obsequious and ignorant sales assistant.

A second sales assistant was a business studies graduate but she didn't speak much.

The translator was a young lady recently graduated in English language studies.

The company was a private company but had all the hallmarks of a Chinese State Owned Enterprise (SOE) with excessive staff, none of whom demonstrated any degree of responsibility except the translator.

A most unimpressive management team. The GM and CTO didn't speak a word of English. Usually the technical managers understand a few technical words which helps the conversation along. Not these two.

The company didn't have a projector.

The GM had a major shareholding in the business but amazingly played no part in the discussions, staring blankly into space most of the time.

He made no attempt to understand our presentation speaking only twice, once to make a totally irrelevant comment in the middle of a technical discussion, the other time to ask a question already asked minutes before by the translator.

The only person with any degree of professionalism was the translator.

She was only 10 months in the company and not only did she translate our questions but she also answered them herself and then followed through with pertinent questions of her own demonstrating a surprising knowledge of the technology which she said she had gained from the internet and from customers, (not from her own management). Sadly her talents were wasted. She had never been to the big city or to any other battery manufacturing plant and believed all the ridiculous claims printed in their sales literature about their high tech factory and state of the art products.

The company had 300 staff in a 10,000 sq metres production facility and no visible means of support. They only have 2 cells in their product range, a 10 Ah cell and a 50 Ah cell, not the diverse range they claimed. The bigger cells they showed, up to 600 Ah, were all wooden space models. They produced only 12,000 cells in the previous month and sales were mostly small volume samples.

Customers are mainly traders most of whom buy from a sales office in Shenzhen. The biggest customer was based in the USA, but nobody could spell their name, not even the GM, so we could not find it on the internet.

The GM admitted they have no patent rights on any of the formulations and no in house special formulations. When asked if we could see the engineering labs we were told they were "in another building". Another way of saying they didn't have any lab.

The quoted temperature range of the cells was incorrect. It should be -20 deg C to plus 60 deg C. Cell voltage is 3.15 Volts not 3.2 Volts.

They have never tested any cells to 2000 cycles. "It takes too long"

The longest cycle test they have carried out was 300 cycles when capacity dropped to 93%. Extrapolating would take this capacity down to 53% in 2000 cycles provided no other failures occurred first. The usual platitudes that quality is their highest priority were repeated. Unguarded comments however indicated a wide process tolerance spread. It appears that the case for their 10 Ah cell is too small for the electrode stack. They claim to be able to produce prototype 200 Ah cells and medium volume in 4 months. This is the same time quoted just for prototypes by one of China's best suppliers who have already been working on the cells for two years.

At lunch the GM and the sales assistant tried the old toasting the guests trick – without success – but the sales assistant ended up with a flushed red face. (For those unfamiliar with the practice, each of the hosts around the table, in this case six of them, will individually toast the guests who, if they are not careful, will end up with six drinks while the hosts have one each. Usually reserved for after hours dining, not for lunches.). The GM disappeared after lunch.

The buildings were only 4 years old but in a shocking state of disrepair with tiles falling off the walls. In the men's toilet in the office block, the U bend was missing from one of the two urinals and the floor was swimming with water, or some other fluids. The factory was a complete disgrace. No need to go into details – just a couple of examples.

The main issue was that the terrazzo/tiled/concrete?? floor had been taken up for some reason leaving at least 6 mm of dust and rubble everywhere and no special precautions keeping this contamination out of the coating and assembly rooms. It looked like it had been like that for weeks as there seemed to be no construction work in progress. For the first time I felt in need of the plastic shoe covers they always hand out on factory visits, not to protect the product and equipment, but to protect my shoes.

The factory space occupation was very low with only a few small batches in production. Work methods and tolerances were uncontrolled. The current take off tabs on the electrodes were cut freeform with scissors into a variety of shapes. The holes punched to accommodate the clamping bolts were all over the place including over the edge of the tabs. The clamping pressure plates were mis-oriented and lock-nuts were not used. The electrode plates were creased and dog eared and corners were turned over.

Somebody is obviously buying this stuff!

This is the kind of supplier from whom many battery traders purchase their products. The trader mentioned above was a customer but he had never visited the plant

In view of the low sales volumes, the unacceptable quality and the large headcount to support, the lifetime of the company could be shorter than their batteries.

At the exit of the factory there was a big poster proudly proclaiming they were ISO 9000 approved.

Industry insiders recommended the next factory as a suitable supplier of high capacity cells for traction batteries. The company is a State Owned Enterprise (SOE) run by the Vice General Manager and party hack who didn't speak English.

She was accompanied by three young "Sales Directors"

The CEO/CTO was based in Beijing University and rarely visits the factory.

He was not present during the visit.

Some of their current sales brochure could have been written by Chairman Mao himself. "*(The company)* has smashed the monopoly of foreign manufacturers in China's Lithium Ion battery cathode materials market", "China's first and only power battery manufacturer" (Untrue state propaganda) Like many of the previous companies visited there was a distinct lack of sales drive???

The Vice GM was the most senior person on site. A humourless, unsmiling, severe character with a look that would frighten the Gang of Four into submission. Her qualifications were "9 years working in the battery industry". She asked no questions during our presentation. Her presentation started with a long political statement about the glories of her government department. (Something like the DTI in the UK). The company is a major Lithium cathode materials producer but specialises in spinel based and Nickel Cobalt powders. She found 20 ways to avoid answering the question whether they were going to produce Lithium Iron Phosphate powders or cells. We can assume this meant No.

They make pouch based cells up to 120 Ah and like many others suppliers they claim to have a contract to make Lithium cells for EV buses for the Olympics. (There are many bus manufacturers in China)

They have converted several cars, vans and buses to demonstrate EVs and they have made 20 batteries for EV buses with capacities between 160 kWh and 200 kWh. They also claim that a European aerospace manufacturer is a customer.

Their brochure shows an impressive battery management system (BMS) but despite this they were interested to buy our BMS product. Some of the claims in the sales literature and their presentation were inconsistent which leads you to question what is the reality.

The materials research facility was reasonably well equipped which is more than can be said of some of the other suppliers visited. There was a large stock of 120 Ah cells lying on the floor in one room. From what we could see

externally, the quality and care of the product were not impressive. Pouch cells are particularly vulnerable.

Having made the long odyssey to the factory we were confined to the offices and not allowed on the shop floor. We were given another 20 reasons why we could not see electrode production or cell assembly. The usual story is that they have confidential technology. More likely they have something to hide.

I suspect we would never be able to agree on objectives. Not a suitable manufacturing partner.

The next visit is an example of the frustrations of arranging supplier visits in China.

Despite arranging the meeting several weeks in advance, after another up country visit by train, bus and taxi the only person present in the factory was the Sales Manager. He had agreed the meeting on a day when the factory was closed. The Technical Manager was not available to answer questions. Sales people were too busy to attend and the senior site manager was out of town. A wasted day when nothing was accomplished. The trader mentioned earlier was also a customer of this company and he had not visited this plant either. Now we know why.

For another plant visit, a sales assistant was sent to our hotel to guide us to the plant. She knew almost nothing about the company or its products and was equally useless as a guide. A prime example of the female species' inability to read maps, her task was to deliver us from the hotel to the factory on a journey which should have taken two hours but took three and a half including going down five dead ends and excursions down single track country lanes until we were finally rescued by a search party from the factory arriving after 4.00 p.m.

The GM studied in the USA and had a PhD in materials science from Japan. He had also worked for a European cell manufacturer. We were shown around the plant by the quality manager. The ridiculous plastic bags most factories make you wear on your shoes fell apart on my over-length shoes only 20 metres into the factory and the he said just forget it and continued the tour leaving the shoe covers behind on the floor.

The plant was relatively new and had no automation at all. Every activity was manual, even winding the electrodes which were wound by hand on small plastic strips forming the mandrels. The factory was clean but there was poor control of tolerances. Despite the obvious deficiencies they claim to sell to Sony, Philips, Thomson, Creative, Samsung, and MSI

Shortcuts

At one plant making high capacity cells, the product was a copy of another Chinese manufacturer's design but with some shortcuts.

The electrode stack inside the case was held together by Scotch tape which deteriorates within 12 months in the high temperature working environment.

They did not use the more durable Kapton and the stack was a loose fit within the case allowing movement and flexing of the current take off tabs connecting the stack to the external terminals. There was no torque control on the clamping mechanism on the current tabs and uncontrolled, oversized insulating tape could interfere with the connection to the terminals. There were also examples of physical damage cells in some of the packs. They had not done any vibration testing.

Relationships

Having the right connections is very important in China, but they can also cause problems. Although the country is a very big place, the battery specialists all seem to know each other.

With the Chinese networks of old friends and old enemies you have to be careful what information you give out. You never know where it will end up. At a meeting with one of our potential suppliers the CTO could not support the development programme we required to produce cells to our customer specification so the supplier was not able to respond to our request for quotation. Shortly afterwards our customer in the UK received an unsolicited offer from a trader, with whom the CTO also had a business relationship, to supply the cells to the specification we had requested.

Confidentiality doesn't exist as top engineers regularly switch companies taking technical and commercial secrets with them. Copying each others designs is not unknown.

Counterfeiting of premium brand batteries has also been reported by Motorola and Nokia but I have not witnessed this personally.

When one supplier was asked how he won so much business from his major customer he confessed that the customer's purchasing director was a shareholder in his company.

Consistency

Once a company has been given a clean bill of health, it doesn't mean you can rely on it to stay that way.

One well known company initially supplied a new generation of high capacity cells though they were reluctant to provide detailed performance data.

Unfortunately the CEO left and was replaced by the despotic, egotistical CTO and things began to change for the worse. In four years the factory was moved to three different locations. The current factory now occupies four multi-storey blocks in a grimy industrial area. Free range chickens and pigs roam around the forecourt within the factory compound.

A series of injection moulding machines for manufacturing the cell cases had been installed between the buildings, covered by a corrugated iron roof but there were no permanent walls between the buildings to enclose the space.

The CEO occupied an enormous office with an ornately carved desk which was almost five metres long.

Inside the main building, one complete floor was dedicated to a private karaoke bar with a full range of facilities including private rooms off to the side, no doubt to entertain unwary buyers and government officials in the evening. We escaped after being pressed into singing a song following the lunch.

In the production area the windows in the electrode coating facility were open to the elements with fans blowing dirt laden air across the factory space. In most factories electrode coating takes place in clean room conditions. There was a complete absence of control charts indicating the state of the production processes. At strategic positions however there were placed almost life sized photographs of the CEO with high ranking visiting government dignitaries.

The company had no materials lab but they claimed to have developed a new Lithium Iron Phosphate chemistry which did not infringe the relevant Goodenough patent. No evidence to justify this was available.

There were no process and quality engineers and every aspect of the business was directly controlled by the CEO who regarded his process as highly secret and accepted no criticism. As a consequence there was a constant staff turnover and though there was a chief engineer we were met by a different one each visit we made.

After initially qualifying sample cells, the cell chemistry, along with the internal electrode construction, was changed by the company without informing us, completely nullifying the qualification tests and cell characterisation which we had carried out back in our own factory.

Sample cells were also submitted to a respected, independent Chinese test laboratory for evaluation and during the safety tests one of the larger cells exploded in a huge fireball. Despite being present myself and having video evidence, the initial response from the CEO was total denial. Then he claimed that the test lab was an unfriendly and dishonest institution and that they had deliberately sabotaged the tests and falsified the results. It was noted that the safety vents were the same size on all cells in the company's range however the rate of release of gas in the larger cells will be much greater than in the smaller cells hampering the venting process in the larger cells.

As part of the purchasing contract, the company was supposed to provide measurement data for the capacity of every cell delivered. On checking, it was discovered that the test equipment utilised in the plant did not have the capacity to carry out the required testing and the capacity measurements were made on blocks of 64 cells. It was thus impossible to determine the capacity of individual cells. Nevertheless the company had sent individual measurements with the cells they shipped.

After raising various quality and reliability issues we were banned from the assembly floor on subsequent visits and denied vital cell performance data.

Problems are not just confined to rogue suppliers like the one above. They can also occur with some of the best manufacturers. A Japanese owned company operating in China with impeccable delivery and quality performance credentials, agreed to develop a custom high power cell to meet the requirements of a major customer. After six months development work, they unilaterally stopped work on the project having reordered their priorities to focus their manufacturing on more profitable, simpler high volume, low power

cells. We were left with the problem of finding an alternative source at short notice and of explaining customer that their project would be delayed.

The Good

Don't be put off by the possible bad experience. There are many high quality energy cell manufacturers in China making excellent products. Manufacturers range from the production plants of the major Japanese cell makers to less well known local companies making huge volumes of cells for the big global players in the electronics business such as GE, Nokia, HP, Dell, Alcatel, Motorola, Philips and Black and Decker. The good cell makers have all invested massively in their Chinese operations installing high volume fully automated factories. Sales revenues upwards of \$200 million per year are needed to justify such investments and some of them have sales volumes of over \$1 billion. They can only win and retain this business by producing high quality reliable products.

Getting access to this capability however is not easy.

It's no use expecting support from any of these companies unless you turn up at their door with a multi million dollar purchase order in your pocket. You will be competing for their manufacturing capacity with the world's major battery consumers. Orders under \$100,000 are a nuisance and don't expect to get them to produce specials for you.

If you want to use cells from one of the major Japanese cell makers you will most likely be referred to the national sales office nearest you and even though the cells are made in China, you will pay Japanese prices not Chinese prices. If you need technical support, it will be provided by your local sales office. You will be offered standard products from their catalogue. If your application demands any special requirements it is unlikely you will get much help unless you can guarantee to purchase huge volumes.

The last thing a Japanese cell maker wants is to damage their brand name. Because of this, they naturally don't want to be associated with any product failures and they will want to know in detail what the application is.

(One Korean manufacturer demanded to know the name of our customer. After several weeks of negotiations with both our customer and the vendor we thought we had a supply deal and we eventually told the supplier who our customer was. Before I got back to Europe they had sent their salesman to visit our customer to cut us out of the deal.)

If there is any chance that your design might be unreliable, especially where high power Lithium cells are concerned, many Japanese suppliers will want to audit your circuit design and maybe even your factory before they will sell to you. A start up company may also be required to provide a bond of several hundred thousand dollars before they will be accepted as a customer.

Chinese companies can offer lower prices but they have no local support in your market. You need to go to them to make your pitch. Even then, unless it is high volume business, it will be met with little enthusiasm. You will most likely be received by a relatively junior sales assistant who will take note of your requirements and take you on a plant tour to show off their wonderful

manufacturing operations. Once more you will be encouraged to buy from their standard product lines. The sales assistant will not have any authority to negotiate technical requirements and on your first visit it is unlikely that you will get to meet any of the senior technical and commercial management. The likelihood of getting any further up the management chain depends on the volume of your business.

Unless you want standard products, the specification sheets can also be a problem. Not because you don't trust them as in some of the examples already discussed. There's no reason why you can't trust the claims of the better companies. Problems occur because they may not contain as much information as you need to complete your design. They will show dimensions, charge/discharge curves, temperature range, pulse performance for a specified pulse duration and cycle life. But what if you want to know the maximum pulse power capability for longer or shorter pulse durations as in regen braking applications. What if you want to know the effect on cycle life of operating in a 60°C ambient temperature or at different depth of discharge levels. What if you need data on possible thermal runaway. While you can be sure that they have tested the cells to the limits specified in their literature, they probably do not have the specific data required for your application. If you are a big enough customer they may set up some tests for you. More likely they will suggest you purchase some cells and do the tests yourself. If you need to know the cycle life of traction batteries under different operating conditions to determine your warranty liabilities, this could be a long and expensive exercise.

How do you survive in this minefield?

For a small company wishing to use Chinese cells, one way around the problem is to work with a trusted pack maker who purchases high volumes. With many customers on their books they can negotiate both prices and technologies from a position of strength so that they are able to gain entry at the highest level and can get cells designed to their own specification if necessary. Maintaining relationships with all the major cell manufacturers and understanding their capabilities and cell technologies is also very important. On-site qualification of all potential cell manufacturers is vital, as is the facility to verify their claims with independent or in-house testing facilities. Perhaps the most essential capability needed to support purchasing in China is full time management of the supply chain. The best solution is to have your own representatives with local knowledge in China to keep abreast of developments and to manage your supplier relationships. They monitor supplier performance to make sure that there are no short cuts, that the supplier processes remain under control, that the goods meet the specification and that they are made and shipped on time. If you don't have the luxury of a local representative based in China, a good pack maker should be able to make these resources and their experience available to you.

Let the buyer beware

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If you need any help or advice about buying batteries or supply chain management in China please contact us at office@woodbank.com and we'll do our best to help you.