

## PFC in high THDu VFD application

-by Sinexcel inverter based SVG technology

A textile factory, first, second and fifth plant have been running for 15 months. Third and fourth plants have been running for 5 months. The main functions of the factory equipment include cotton cleaning, carding, drawing, roving, spinning, winding, etc. It requires highly automation and precise control for the equipment to save energy. This is why there are mass of Variable Frequency Drives. The PFC effect is not obvious by using capacitor banks compensation. THDu is generally high up to 12% to 14%, and PF is ranging from 0.83 to 0.87, which cannot meet the standard demand PF 0.9 and the factory was facing high penalty.

Five months later, a large number of capacitors are damaged frequently in third and fourth plant. Its enclosure became deformed due to the inner expansion, or even on fire with explosion. It caused huge economic losses and distressed owner so much for the safety risk.



Figure 1(Cap bank explosion)

**1 Why large number of VFD application would cause high THDu?**

**And what is the impact on the capacitor under high THDu?**

The harmonic current of factory system is determined by the system impedance  $L_s$  and line impedance  $L_d$  together. The percentage of transformer's short-circuit impedance is 7.5%. It limits the harmonic current, so that the THDi is 11% and harmonic content is around 200A. But the system impedance  $L_s$  has the shunting effect, which forms a large electric potential difference on transformer short-circuit impedance. Finally it caused high THDu. There are a lot of 100kW inverters in the factory, and they are as voltage source of harmonic. This is also why the THDu reached at 12%-14%, which surpass the standard 1% to 5%.

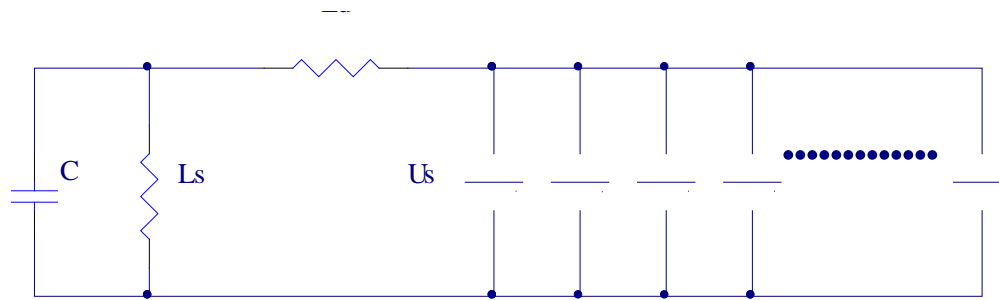


Figure II(schematic)

When the harmonic order increase, due to features of capacitor itself, the harmonic current through capacitor will be increased also. Larger harmonic current will increase the inner temperature of capacitor. All of these led to capacitor's inner expansion, on fire, severe discharge, flashover, contact point overheat etc. Capacitive devices are very sensitive to THDu because harmonic current is influenced most by the harmonic order. Resonance circuit will happen when the capacitors and the line impedance are at the same resonance condition. Harmonic current will also be amplified by capacitors and then made the rectifier and other electrical equipment face over current risk, resulting damage in input circuit.



Figure III(Capacitor explosion and

oil spilling)

## 2 How to upgrade/replace capacitor banks by Sinexcel SVG?

Traditional cap banks compensation is no longer applicable for this factory because of high THDu. However, SinexcelSVG could still perform perfect PFC under THDu 15% because Sinexcel SVG is based on inverter technology, which can generate compensation current by IGBT to avoid resonance and harmonic amplification. Also Sinexcel SVG is capable to endure stronger harmonic voltage. The textile factory has integrated Sinexcel SVG modules into previous cap bank cabinet, which significantly saved the cost of customer. After installing 16000kvar Sinexcel SVG, the system performs perfect compensation with PF0.99.



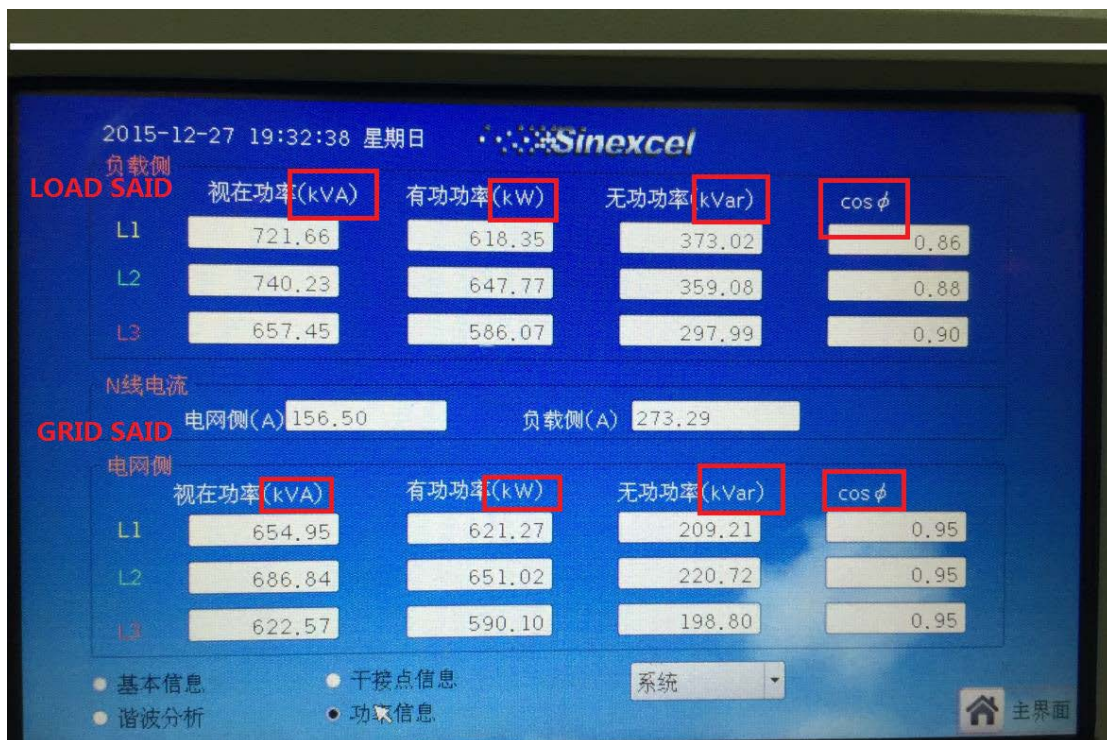
Figure IV(Reconstruction project)



Figure V(Reconstruction project)

Parameter	Before compensation	After compensation
PF	0.88	0.96
Parameter	Load side (A phase)	Grid side (A phase)
Reactive power (kvar)	360	200
Active power (KW)	618	622
Apparent power (KVA)	719	655

Table 1(Data before and after compensation)



**3 The customer value of Sinexcel SVG**

- Reactive power compensation from the electronic power supply system to improve the PF of the effect.
- Reducing loss of power transformers and transmission lines to improve power efficiency.
- Improve power supply environment.
- Reasonable choice compensation device, can be done to minimize power loss, improve power quality.

**Difference between SVC and SVG**

**SVC(Capacitor bank)**

The reactive power compensation principle of cap bank is to utilize its own properties of capacitive capacitor to govern the power factor of the grid. Capacitor banks are used by group switching on/off. Its output current is step by step/group by group, which usually leads to over-compensation or under-compensation. The power factor correction is between 0.8 and 0.9.

**SVG**

- 0.99~1 PFC performance
- 1~1 both capacitive and inductive load PF compensation
- Step-less compensation, real time 15ms to finish PFC
- No resonance, No over/under compensation. Adapt to complicated and fast switching applications
- will not be impacted by harmonic, will not generate harmonic, either
- High power up to 100Kvar/module
- Modular design concept, could be integrated into self-design cabinet, the same as capacitor bank
- Rating power is equal to compensation power
- Compensation power would not be reduced by voltage drop

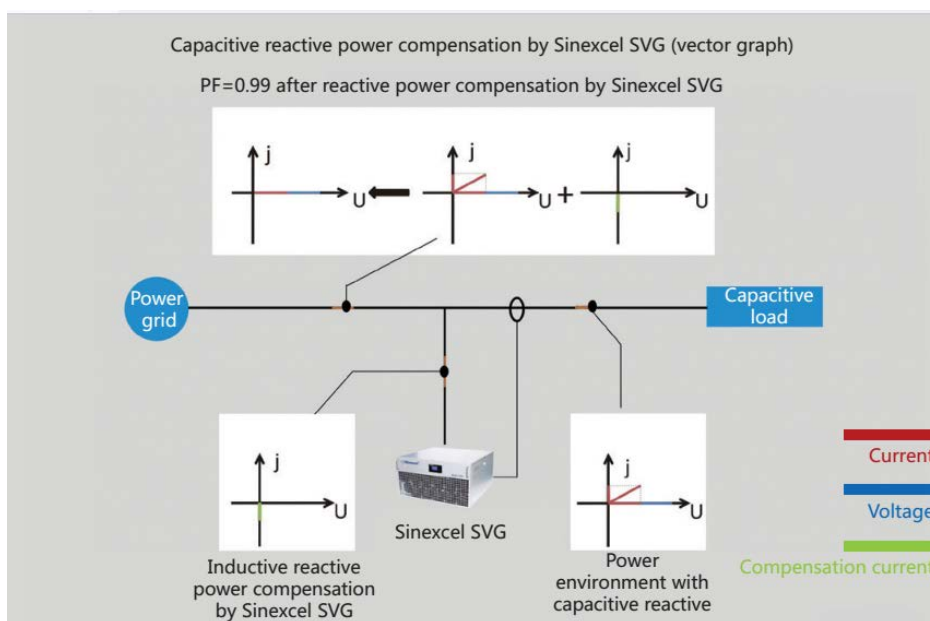


Figure VII

**How is the performance of SVG?**

PFC with high accuracy

PFC at 0.99 consistently

PFC with stepless compensation the specific kvar per system required

PFC with fast response 15ms

**PF**

Sinexcel SVG could achieve the compensation effect of 0.99. SVG modules can cover all blind points and implement stepless compensation, performing no over or under compensation.

**Space and safety**

Ultra compact modular design makes Sinexcel could be used as component to install in customers' cabinet. No safe risk by expansion and explosion as cap banks.

**Life and cost**

Its loss is minimal and free maintenance. Moreover, its lifetime is up to ten years and it helps consumers lower the cost and truly takes consumers demand into consideration just as Sinexcel consistent principle: the success of the costumers is our success.