

## Civilization 254

### Chapter 254 Derivation and Toppling

A strong breeze swept across the shores of Lake Texcoco, brushing over the crowd on Heavenly Fire Island and gently fluttering the white, long feather in the young boy's hand. Blue skies, white clouds, and islands in the lake, followed by thin blue smoke and a youth in black... all appeared as though captured in a painting.

Xiulote sat poised on the grass, a sheet of white paper flat on his lap cushioned by a wooden board below, with a quill elegantly skipping across, occasionally jotting strange symbols. Since the completion of the paper-making, his writing tools had once again evolved: white paper, quill, and blue ink, indeed a refinement over charcoal and boards.

Bertade surveyed the crowd placidly, and the samurai dispersed knowingly to stand guard, patiently awaiting. Noticing the waiting female workers, the Head Warrior pondered for a moment, his eyes suddenly brightening. Immediately, he smiled and gestured for the pottery girl to come over, then handed her the ink pottery jar and stepped back ten paces.

Taking the pottery jar, Talaya's eyes curved into a smile. Holding the blue ink jar with her fair hands, she sat close beside the young boy, her legs drawn up.

Xiulote initially wrote  $\text{KNO}_3$  Saltpetre, C Charcoal, and S Sulfur on the left side of the paper, then  $\text{N}_2$  nitrogen and  $\text{CO}_2$  carbon dioxide on the right. Following that, he sighed sorrowfully and wrote K? S?... Why didn't I study well back then?...

"Could K be  $\text{K}_2\text{O}$ ? Could S be  $\text{SO}_2$ ? What exactly are the oxidation and reduction processes involved here..." Talaya leans in to listen but hears only the prince's Heavenly Divine murmurs; she can't help but rise slightly, leaning closer.

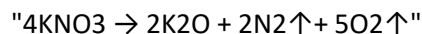
Xiulote, engrossed in thought, decided to start from the beginning by writing out the periodic table. He dipped his pen in ink, paying no mind to Talaya beside him, merely smelling the faint fragrance of the ink... Hmm, this ink smells pleasant.

Soon, the young man began writing with an H, got stuck for a while before he fluently continued with C, N, O, F, Ne, Na, Mg, Al, Si, P, S, Cl, ?, K, Ca; then thought, let's leave something for future chemists.

Xiulote looked at his masterpiece, a smile of satisfaction and confidence crossing his face. This would be a groundbreaking contribution, advancing humanity's future ahead of time!

Beside him, Talaya opened her mouth slightly, utterly absorbed in watching the prince, captivated by that moment of confidence and flair.

Lost in thought for a moment, the young man began to formally derive the complete reaction process of gunpowder combustion. First, if there are no C and S, KNO<sub>3</sub> would decompose when heated to produce K<sub>2</sub>O potassium oxide, N<sub>2</sub> nitrogen, and O<sub>2</sub> oxygen, and the balanced reaction should be:



Then, Xiulote paused slightly, and below O<sub>2</sub>, he sequentially wrote S and C. Since there are S Sulfur and C Charcoal in gunpowder, but S Sulfur more reactive, it should burn first to produce SO<sub>2</sub> or SO<sub>3</sub>. Then, when heated to three or four hundred degrees, C Charcoal would undergo an oxidation reaction to continue releasing heat.

"Oh, K<sub>2</sub>O with H<sub>2</sub>O makes KOH, which is strongly alkaline. Since K<sub>2</sub>O is strongly alkaline... it should react with acidic oxides first, hmm, that should be SO<sub>2</sub> or SO<sub>3</sub>..." Talaya's eyes widened and her ears twitched. Watching the mysterious symbols, she gazed at the prince's profile, imagining a divine communication with the King.

Xiulote thought hard while writing down the equation.

"K<sub>2</sub>O + SO<sub>2</sub> → K<sub>2</sub>SO<sub>3</sub>... followed by adding O<sub>2</sub> oxygen... anyhow, after complete oxidation, it should all become K<sub>2</sub>SO<sub>4</sub>... Then what? What comes next?" Talaya detected a hint of distress in the prince's words, as if the divine communication was proving challenging, and she too began to worry.

The young man fell deep into thought again. He propped his forehead with his hand, pondering long and hard; at that temperature, the combustion should be extremely high, enough for elemental C to undergo an oxidation reaction, then the hexavalent S in K<sub>2</sub>SO<sub>4</sub> should be reduced by C. In conditions rich with C, S should be reduced to the divalent state, ideally pairing with K.

After much consideration, Xiulote continued to write.

"K<sub>2</sub>SO<sub>4</sub> + 2C → K<sub>2</sub>S + 2CO<sub>2</sub>↑"

At that point, all the intermediate steps were roughly linked together. The youth thought deeply for a moment, first the unstable decomposition of KNO<sub>3</sub> saltpetre, followed by the oxidation of low-melting-point sulfur, and only after continuous heating did the high-melting-point carbon oxidation exotherm occur. The entire reaction would produce a large amount of gases and release a tremendous amount of heat. In combustion, SO<sub>2</sub> was the early oxidation product, and with the optimal complete ratio, the final product would be K<sub>2</sub>S!

Logically, there were no issues, and Xiulote smiled confidently again. He dipped his pen in ink, then deeply inhaled the fresh aroma.



This was indeed the optimal ratio for the complete combustion reaction of black gunpowder. The mass ratio of the reactants in the reaction formula was exactly the weight ratio of the three ingredients in black gunpowder!

Subsequently, the youth focused again and began calculating molar masses; nitrogen in KNO<sub>3</sub> was 14, oxygen 16, potassium... potassium was slightly less than calcium, calcium 40, so potassium should be 39, hence 2KNO<sub>3</sub> equaled 202, 3C equaled 36, S equaled 32.

Thus, based on the calculations, the optimal ratio for black gunpowder should be: saltpetre 202, sulfur 32, charcoal 36, that is, 74.6%, 11.9%, 13.5%. However, in practical explosions, charcoal often could not completely burn, so slightly more should be used instead of sulfur, making it 75:10:15, which was 15 parts saltpetre, 2 parts sulfur, 3 parts charcoal!

Xiulote looked back at the Mnemonic Verse "one saltpetre, two sulfur, three charcoal" and realized that the "one" for saltpetre referred to 1 jin, which was the old jin of 16 liang, the "two" for sulfur was 2 liang, and "three" for charcoal was 3 liang. This precisely matched the calculated 15 parts, 2 parts, 3 parts.

"So that's how it is!" Having finally deduced the ratio of gunpowder, a joyous smile spread across Xiulote's face. Then, the youth abruptly threw away his pen and paper and excitedly stood up, but his shoulder unexpectedly bumped into something soft.

A gentle cry was heard as a pottery-making girl fell backward, her soft long hair brushing over the youth's face, lifting a breeze. In the moment of weightlessness, she stretched out her arms, timely grasping His Highness's arms, pulling with all her weight downward.

Upon hearing the noise, Xiulote turned his head only to see the startled Talaya. His heart skipped a beat, and he halted his instinctual defensive action. Then, he was powerfully pulled, lost his footing, and his balance swiftly faltered. Within two breaths, he had completely lost balance and fell over with the pottery-making girl beneath him, followed by another soft cry.

Xiulote was on top, feeling the softness of the body beneath him, his heartbeat suddenly quickened. He turned his head, before him were Talaya's bright eyes, her beautiful face, and her unraveling long hair, while his ears were filled with the girl's close breathing, and his nose was teased with a faint lingering body fragrance... the youth was suddenly lost in thought.

Talaya's eyes widened, and as she felt the young man's body on her, her face slowly reddened. Then, she suddenly closed her eyes, like a waiting kapok flower, blooming with an inviting hue.

Seeing this scene, the workshop became silent, the samurais looked at each other. Moments later, the female workers audaciously started to promote excitement. Everyone had solemnly awaited a "Divine Revelation" for a long time, yet it unfolded in such an exhilarating manner. Not far away, Bertade's solemn face disappeared, he smiled joyously amidst his weathered look. He quietly spoke, about to command everyone to back down.

Stunned for a moment, Xiulote forcefully shook his head, then struggled to rise from the ground. Then, he pulled Talaya up from the ground as well and carefully brushed the dust off her.

Afterward, the young man took several deep breaths, then calmly spoke.

"Every pottery jar 15 parts saltpetre, 2 parts sulfur, 3 parts charcoal, recalibrate gunpowder... not to be disclosed!"